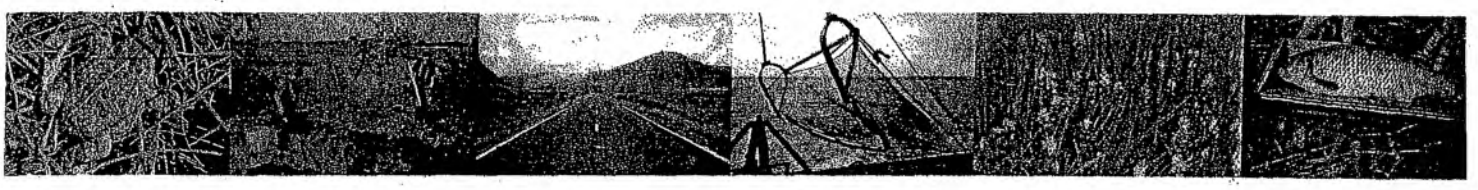

MERSEY ESTUARY
BASELINE BIOLOGICAL SURVEY

ANALYSIS OF MACROINFAUNAL SAMPLES, LITERATURE REVIEW AND DATABASE PRODUCTION

Final Report

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1. INTRODUCTION

1.1 Project background

1.1.1 This report presents an ecological review of the Mersey estuary along with an extensive bibliography of the available environmental literature for this system. The bibliography has been compiled both to facilitate the ecological review process and to underpin the Environment Agency's ongoing management of the Mersey estuary. With the latter objective in mind, the bibliography is also available as an interrogatable Microsoft Access 97 database that is designed to be used, and developed, by the Environment Agency and all other parties involved in the conservation and management of this system.

1.1.2 This ecological review and database production work has been undertaken on behalf of the Environment Agency (Warrington) as part of their 'Mersey Estuary Baseline Biological Survey' programme. The central objective of this programme has been to provide the information necessary to support the Environment Agency's review of existing and future consents (for discharges, abstractions etc) in the Mersey estuary. This review of consents is required because the Mersey has been designated as a Special Protection Area (SPA) under the EC Birds Directive. Therefore, under Regulation 50 of the Conservation (Natural Habitats, &c.) Regulations 1994, the Environment Agency (as the competent authority in this case) is responsible for reviewing any extant consents, or future applications, that may directly or indirectly affect this SPA.

1.1.3 For the consents review process, an Appropriate Assessment (AA) will need to be undertaken to determine whether each consented activity (either alone or in combination with other activities) has a significant effect upon the SPA interest features for the Mersey. This assessment must be taken in view of the site's 'conservation objectives' and, where a significant effect is identified, it must in turn consider whether the integrity of the SPA would be affected. To facilitate the decision making process for these Appropriate Assessments the Environment Agency require a comprehensive description of the Mersey estuary environment and an indication about where gaps exist in our current understanding of this system.

1.1.4 To support this baseline description of the Mersey environment the Environment Agency carried out a benthic invertebrate survey which covered all areas of the inner estuary and the 'Narrows' region of the outer estuary. This survey was carried out during August and September 2001 and, as part of the present review, the samples collected during this survey were analysed to produce a description of the diversity and structure of the invertebrate communities and their spatial variability across the estuary.

1.1.5 In summary therefore, the 'Mersey Estuary Baseline Biological Survey' programme has involved the Environment Agency benthic invertebrate survey and the following elements which are reviewed in this report: -

- Laboratory sample processing and identification of macroinfauna for 53 intertidal and subtidal benthic samples that were collected by the Environment Agency during the 2001 benthic survey.
- Statistical analysis and review of the results from the Environment Agency benthic survey.
- Extensive consultation and data sourcing exercise to identify available sources of information on the environmental characteristics of the Mersey estuary.

- A desk based review of the Mersey estuary's ecology based on key information sources obtained during the consultation process.

- The production of a bibliography an interrogatable metadatabase of environmental information for the Mersey estuary.

1.1.6 The majority of this work has been undertaken by Young Associates (Environmental Consultants) Ltd with key inputs from the following two consultancies: -

- Marine Biological and Chemical Consultants (MBCC) who carried out the laboratory analysis (sorting, identification and enumeration) of the Environment Agency's benthic macroinvertebrate samples.

- Compass Computer Consultants (CCC) who provided technical input and advice for the production of the metadatabase.

1.1.7 Details of the approach that was taken for this commission are presented below and the results and recommendations of the review process are detailed in Sections 2 and 3 respectively. Section 4 of this document then presents a guide for those utilising the database, which is contained on an accompanying CD-ROM.

1.2 Approach

1.2.1 This section reviews the methods employed for the analysis of samples collected during the Environment Agency's benthic survey as well as those pursued for the data collation, data review and database production elements of this commission.

Macroinfaunal Analysis

1.2.2 The Environment Agency 2001 survey involved the collection of 53 benthic samples (17 subtidal and 36 intertidal) across the Mersey estuary. The location of the Mersey estuary and the position of the Environment Agency's benthic survey site locations are shown in Figures 1 and 2 respectively.

1.2.3 For this benthic survey the intertidal samples were collected using a $0.01m^2$ core sampler and the subtidal samples were collected with a $0.1m^2$ Day Grab. Only a single 'replicate' sample was taken at each site because it was the intention of this survey to provide an overview of the Mersey benthos that can be used to inform the ongoing monitoring and assessment work. Due to the inherent spatial variability of benthic communities it is standard Environment Agency practice is to take 5 replicate samples in muddy sediments and 10 replicates in sandy areas (where communities are more variable). For this baseline survey however, it was concluded that such detailed monitoring was not required given the remit of the project. However, standard EA practice will probably need to be adhered to for any future monitoring programmes that may be pursued following this baseline overview.

1.2.4 After collection, and a period of temporary storage in formosaline solution, the samples were forwarded to the MBCC laboratories for the; sample processing, invertebrate identification and enumeration stages of the sample analysis work. On receipt these samples were firstly washed thoroughly with freshwater to remove traces of preservative and the fauna were then sorted out from the sieve residue using a low power binocular microscope. All the macrofaunal specimens were then identified to species level (where practicable) and enumerated. Finally, measurements of the wet weight biomass (to an accuracy of 0.0001g) for the individual taxa within each sample was made using Environment Agency standard

methods. Wet weight biomass was measured in accordance with the contract specification although it was recognised by the Environment Agency that ash free dry weight (AFDW) is a more accurate indicator of biomass. However in the interests of preserving the fauna for any future audits this approach was not carried out.

1.2.5 During all stages of the analysis relevant Analytical Quality Control (AQC) procedures were adhered to. These were based on those used by the Environment Agency (Environment Agency 1996) and involved the inspection of 10% of analysed samples. All samples, including AQC samples, are available to be audited by an external analyst on behalf of the client. In addition, during the identification process a voucher collection of all taxa encountered was compiled which is also available for review.

1.2.6 Analysis of the resulting species-abundance matrix was carried out using PRIMER (Plymouth Routines in Multivariate Ecological Research) software to describe the spatial patterns of the intertidal and subtidal communities. These results were compared against those obtained by other similar studies, of which possibly the most valuable is the detailed investigation of the invertebrate-waterfowl interactions in the Mersey estuary that was carried out by Environment Resources Ltd (ERL) on behalf of the BTO (Rehfisch *et al.*, 1991; Holloway *et al.*, 1992; McGill et al., 1992).

Consultation and Data Collation

1.2.7 In order to collate as much information as possible about the Mersey estuary, Young Associates carried out a detailed review of published literature and engaged in an extensive consultation exercise to source further published as well as unpublished materials (grey literature). For this consultation process a wide range of parties including statutory and non-statutory authorities, universities, consultancies and private individuals were invited to contribute data and reports and to identify their in-house data sources. In total there were over 50 consultees and a full list of these, along with their relevant contact details and a summary of the responses received, is presented as Appendix 1 of this document. Following this consultation process and the review of published literature a large bibliography of environmental information sources for the Mersey estuary was obtained (in total over 330 references).

Database Production

1.2.8 The information sources collated during the consultation and literature search phases of the project were compiled into a metadatabase using Microsoft Access 97 software. This database was set up in a way that allows all users to view the bibliography and add further references as required. However, general users will not be able to edit previous entries which can only be done by Environment Agency staff (or parties with password access) who can view the underlying metadatabase table. All additions to the reference list will require a minimum set of information to be entered which will including details about the person/organisation entering the information so that all the additions can be traced.

1.2.9 The database can also be interrogated by all parties in order to select out references based on document titles (or selected words in the titles), author, year of publication or the document source. To facilitate this data searching procedure a series of around 60 subject headings were identified and one or more of these headings were linked to each of the references. Therefore, the bibliography can be searched on the basis of its subject matter and the issues it addresses rather than just the specific words within the title of the document. Further details about the database, and instructions for its operation are presented in Section 4 of this report.

2. REVIEW OF MERSEY ESTUARY ECOLOGY

2.1 Physical Characteristics

2.1.1 The Mersey estuary is 50km long (from its tidal limit at Warrington) and drains a catchment of 4500km^2. In geomorphological and environmental terms it is traditionally divided into the following four sections,

- **The upper tidal estuary.** A narrow section extending downstream from Warrington to Runcorn (upstream of a sandstone ridge 'Runcorn Gap' which constricts the estuary).
- **The inner estuary.** A large open basin characterised by extensive intertidal flats and channels of variable morphology and an area of accretion for sediments imported from the coast (also primarily the region covered by the Mersey SPA).
- **The Narrows.** The narrow mouth of the estuary which reaches depths of 20m and has strong currents (spring tide currents exceed 2.5m/s or 5 knots) that prevent the accumulation of sediments (including the Mersey Narrows which is part of an SSSI and a proposed SPA).
- **The outer estuary.** Extending from the estuary mouth out to Formby and Dove Points consisting of large area of intertidal sand banks.

These four regions of the estuary are illustrated in Figure 3 which reproduces a map from the Mersey Estuary Management Plan (ULST 1995). This map also describes the key socio-economic and environmental features as well as sites of importance in these four areas (at the time of the Plan's production in 1995).

2.1.2 Along with the changes in estuary morphology across the four areas detailed above, clear spatial changes in the sedimentology of the estuary are observed in response to changes in the tidal/flow regime. Along the estuarine gradient the substratum is typically composed of: medium sand in the Narrows; fine sand in the inner estuary; very fine sand upstream of the Hale and silt/clay deposited in slow flowing regions at the estuary margins especially at Frodsham Score, Ince and Stanlow Bank.

2.1.3 Another characteristic of the Mersey is that there is a limited exchange of water between the estuary and the coast (Cole and Whitelaw 2001; ULST 1993). ULST (1993) estimated the Mersey estuary flushing to be 30 days, for material discharged at Howley Weir due to the narrow width of the estuary mouth and the effects of residual flows. These residual flows are created from the vertical differentiation of freshwater run-off moving seawards at the surface and saline water moving land wards over the bed. Modelling and field work by Liverpool University have shown that it is these density currents that promote the movement of sediments from Liverpool Bay into the estuary. These effects coupled with the influences of longshore drift, and near bed flows in the Mersey approach channels, result in the net transference of sediments from the coast to the inner estuary.

2.1.4 As a result of the import and subsequent deposition of sediments in the inner estuary, there are large expanses of intertidal flats in this area. These intertidal sediments are typically dominated by *Macoma balthica* and smaller numbers of *Hydrobia ulvae* and variety of Polychaetes (e.g. *Nereis diversicolor* and *Nephtys hombergii). Capitella* spp. and the oligochaete *Limnodrillus* spp. are also characteristically recorded in organically enriched sediments in the north bank of the inner estuary.

2.1.5 Following high levels of pollution since the 1930's reduced invertebrate species diversity has historically been in evidence but in subsequent years an improvement in invertebrate diversity has been observed which is believed to have contributed to a dramatic increase in the numbers of birds during the 1970's.

2.2 Conservation Importance of the Mersey Estuary

2.2.1 The area referred to as the Inner Mersey estuary has been classified as a Special Protection Area (SPA) under Article 4.2 of the EC Birds Directive. This SPA site essentially covers the intertidal habitats of this estuary (from mean high and mean low water marks) between Runcorn Bridge to the east and Bromborough to the west and also includes some land not covered by tidal waters (English Nature 2001). The boundaries of the site are indicated in Figure 4.

2.2.2 This area qualifies for SPA status because it supports internationally important populations of regularly occurring migratory (wintering) species. The qualifying species and their abundances in the Mersey (as quoted in the SPA citation and based on 5yr peak means from the period 1987/88 to 1991/92) are as follows: -

- dunlin (*Calidris alpina*) - 32,528 birds (2.3% of E. Atlantic flyway)
- redshank (*Tringa totanus*) - 4,080 birds (2.7% of E. Atlantic flyway)
- pintail (*Anas acuta*) - 5,925 birds (8.5% of NW European population)
- shelduck (*Tadorna tadorna*) - 4,510 birds (1.8% of NW European population)
- teal (*Anas crecca*) - 11,705 birds (2.9% of NW European population)

Internationally important numbers of two wader species in (autumn passage)

- ringed plover (*Charadrius hiaticula*) - 1,453 birds (2.9% of E. Atlantic flyway)
- redshank (*Tringa totanus*) - 3,516 birds (2.3% of E. Atlantic flyway)

2.2.3 The Mersey estuary also qualifies for SPA status because it regularly supports over 20,000 wintering waterfowl and the total number of individual birds within the SPA citation (again based on 5yr peak mean from 1987/99 to 1991/92) is 78,015 (comprising 47,714 wader and 30,301 wildfowl species).

2.2.4 Of additional, but non-qualifying, interest the Mersey estuary also holds nationally important numbers of the following overwintering species: -

- wigeon (*Anas penelope*) - 2.6% of the GB Population
- grey plover (*Pluvialis squatarola*) - 4.1% of the GB Population
- black-tailed godwit (*Limosa limosa*) - 2.2% of the GB Population
- curlew (*Numenius arquata*) - 1.6% of the GB Population

2.2.5 As well as the qualifying species, a number of sub-features (habitats) are also identified (EN 2001) which are 'ecologically important components of the European marine site for each interest feature'. These important components are: intertidal sediments mudflats and sandflats (which provide extensive feeding areas for waterfowl), rocky shore and saltmarsh (which provide both feeding and roosting areas for waterfowl).

2.2.6 In addition to its SPA status the Inner Mersey area is also designated as an internationally important wetland site (Ramsar site) under the Ramsar Convention and is a SSSI under the

Wildlife and Countryside Act 1981, as amended 1985. The outer estuary and the North Wirral foreshore is also currently an SSSI and has been proposed (but is not yet classified) as a SPA because it regularly supports at least 20,000 waterfowl including overwintering populations of the following two species: -

- redshank - 1,981 birds (representing at least 1.3% of E. Atlantic wintering population)
- turnstone (*Arenaria interpres*) 1,138 birds (representing at least 1.6% of the wintering Paleartic population).

These abundances, and percentage abundances, are based on 5yr peak means from the period 1991/92 - 1995/96.

2.3 Consents Review and Conservation Objectives

2.3.1 As detailed in the previous section, the Mersey estuary has been classified as a SPA because it supports high numbers (>20,000) of overwintering waterfowl as well as internationally important numbers of the following species: dunlin, redshank, pintail, shelduck, teal and ringed plover. Therefore, the ultimate objective of the Environment Agency's consents review process will be to determine whether extant or proposed consents have a significant impact on these specific ornithological 'Interest Features'.

2.3.2 To provide a context for these assessments, Section 3.2 reviews the current ornithological status of the estuary and compares the abundance of key qualifying species in recent years against the abundance quoted for the SPA citation and also reviews these changes in the context of national trends.

2.3.3 For the assessment work any judgements about the scale of the ornithological impacts should be made in relation to the specific abundance levels quoted within the SPA citation (as stated under PPG9). The assessment process will also need to consider any changes to the SPA citations that may occur following the SPA review.

2.3.4 In addition to addressing the impacts to bird populations an assessment of impacts as part of the Environment Agency's Consent Review should be tested against the relevant conservation objectives for the site which are set out in the English Nature advice under Regulation 33 of the Habitats Regulations (English Nature 2001). These conservation documents recognise the spatial and temporal variability of bird populations, and their responses to impacts. Therefore, the advice emphasises a requirement for maintaining a '*functional estuary, which is capable of supporting intertidal habitat for feeding and roosting*'.

2.3.5 The important factors identified in the English Nature advice document for maintaining estuarine ecosystem function and ornithological value are as follows: -

- Extent and distribution of suitable feeding and roosting habitat (e.g.- intertidal sediments, saltmarsh and rocky shores);
- Sufficient food availability (e.g.- molluscs, crustaceans, worms and insects, soft-leafed and seed bearing plants);
- Levels of disturbance consistent with maintaining conditions for bird feeding and roosting;
- Water quality necessary to maintain intertidal plant and animal communities, and
- Water quantity and salinity gradients necessary to maintain saltmarsh conditions suitable for bird feeding and roosting.

The Conservation objectives identified by English Nature are presented in Appendix 2.

2.3.6 English Nature's Regulation 33 advice document also identifies potentially damaging operations in order to inform the Appropriate Assessment and Consents Review procedures required under Regulations 48 and 50 of the Habitat Regulations.

2.4 Waterfowl distributions

2.4.1 This section reviews the changes in waterfowl abundance since the SPA citation and the general contemporary ornithological characteristics of the Mersey estuary are reviewed in this section. This review draws upon the following reports:

- The most recently published WeBS counts for the Mersey estuary (Pollitt et al., 2000 and Musgrove et al., 2001).
- A review of low tide distributions of birds across the Mersey as presented in the 1998-99 WeBS annual report (Pollitt et al., 2000).
- A review of the status of key waterfowl species in Mersey estuary compared against their SPA citation levels and national abundance trends (Young Associates and Andrews Ward Associates 2000).
- Two British Trust for Ornithology (BTO) studies carried for the Mersey Barrage Company which reviewed the relationship between waterfowl and invertebrate prey in the Mersey estuary (Rehfisch et al., 1991 and Holloway et al., 1992).

2.4.2 To summarise the changes in waterfowl abundance over the last five years the annual peak abundance for all overwintering waterfowl and for each SPA species (from published WeBS counts) are shown in Table 1. This table illustrates the recent temporal trends in these abundance values, and also enables a direct comparison to be made between the current abundance levels in the estuary and the levels for which the SPA was originally qualified. Based on the results in this table and the findings in the above listed reports, the following section summarises the status of each key species in the context of national and regional trends. It also notes the key feeding areas for these species (as also described in Figure 5 and 6).

General ornithological characteristics

2.4.3 It is evident from the WeBS results presented in Table 1 that, between 1994 and 1999, shelduck, teal, pintail, dunlin and redshank have consistently been present at internationally important levels within this estuary. However, the following non-SPA species have also exceeded their international abundance thresholds during recent years: black-tailed godwit, turnstone and wigeon. Of these wigeon and black-tailed godwit were cited as being present at nationally important abundance levels under the SPA citation. Since the citation, the following have been recorded at nationally important levels on one or more occasion: grey plover, curlew, great crested grebe and golden plover (the latter two species that were not recorded as being of even non-qualifying interest within the SPA designation).

2.4.4 In line with these favourable trends, it is also clear from the results presented in Table 1 that the peak abundance of overwintering waterfowl has increased and has remained at a relatively high level since the citation. It is also evident that most individual species, with the notable exception of pintail, are present at abundances that are equivalent to, or much greater than, the levels identified within the citation. This overall increase is attributed by English Nature to the improvement in water quality in the estuary, although, it is possible that shelduck and to

some extent dunlin, are benefiting from the fall in numbers of pintail (part of a wider west European decline) as all three species feed on large numbers of *Hydrobia ulvae*

2.4.5 At a national scale the majority of these species are at higher population levels than when indexing commenced although some have declined since the year of classification of the Mersey SPA (shelduck, pintail and dunlin). Shelduck and dunlin have increased on the Mersey while their British totals have been falling. As with the general increase in waterfowl species the increase in abundance of these two species may be due to water quality improvements and a reduction in competition as stated above. The following sections review the status of these and other key waterfowl species in the Mersey.

Table 1: Abundance of waterfowl in the Mersey estuary from 1994-1999 compared against SPA-cited abundance levels.

	SPA abundance (87/88 - 91/92)	**94-95**	**95-96**	**96-97**	**97-98**	**98-99**	**5yr mean (94-99)**
Total waterfowl	78,015	90,638	116,030	117,312	93,910	106,031	104,784
SPA Species	**SPA abundance (87/88 - 91/92)**	**95-96**	**96-97**	**97-98**	**98-99**	**99-00**	**5yr mean (95-00)**
Dunlin	32,528	40,501	55,430	52,015	70,887	42,120	52,181
Redshank	4,080	4,710	5,212	6,973	5,087	4,476	5,292
Pintail	5,925	873	904	813	882	1,100	914
Shelduck	4,510	4507	7025	14516	10600	15070	10344
Teal	11,705	7734	14210	12065	9393	11700	11002
Ringed plover	1,453 (1989)	Not pub'	Not pub'	1,428	Not pub'	Not pub'	Not pub'
Non SPA Spp		**95-96**	**96-97**	**97-98**	**98-99**	**99-00**	**5yr mean (95-00)**
Bl-tailed godwit	N/A	494	1,703	2,655	1,573	976	1,480
Turnstone	N/A	2	1717	1188	1727	703	1,067
Wigeon	N/A	11,254	12,133	10,520	12,013	8,731	10,930

The international thresholds are: - Dunlin, Redshank (1,500), Pintail (600), Shelduck (3,000), Teal (4,000), Ringed plover (500), Ba-tailed godwit (1,000) Bl-tailed godwit (700), Turnstone (700) and Wigeon (12,500).
Shaded areas indicate where WeBS annual review identifies species as being at internationally important levels (NB on occasion international thresholds have also been exceeded, on an annual basis, at other times).

Shelduck

2.4.6 The annual indices for shelduck show that the British wintering population of this species has remained relatively stable over the past 35 years although over the last three winters peak counts for this species have consistently declined and numbers in 1999-2000 were the lowest since the 1970's. In the Mersey however numbers of shelduck have been particularly high during this same three-year period with the result that the relative importance of this site for

this species has continued to increase. In 1999-2000 shelduck abundance (15,070) was the highest at any site in the country over the previous five years. Significantly, the peak abundance for this species occurs during either August or September and the WeBS counts have shown that more shelduck are staying in Britain over the late summer autumn period to moult rather than departing for the Wadden sea (Cranswick et al., 1999; Musgrove, 2000). Thus, it would appear that the Mersey is now an internationally important moult site for this species. Shelduck are universally distributed across the estuary (Figure 6d) with the greatest feeding concentrations occurring off Ellesmere Port and, to a lesser degree, at Rock Ferry (Pollitt 2001).

Teal

2.4.7 In the mid 1950s two severe winters resulted in a drastic decline in the north-west teal population from which the population subsequently recovered. Since then numbers declined slightly, probably due to the birds dispersing to the Dee and Ribble, but in recent years the British index has increased steadily (Batten et al., 1990, Cranswick et al., 1999.) and in 1999/2000 rose to its highest level ever (Musgrove et al., 2001). Despite a dip in the peak core count in 1995-96 (Table 1) the Mersey estuary remains the second most important site in Britain for teal. This stability in the annual counts for teal (which is relatively atypically for wildfowl species) has also been observed at other key sites in the UK (Musgrove 2001).

2.4.8 Teal are shallow water feeders, dabbling at the edges and upending to feed predominantly on plant seeds (such as *Atriplex* and *Salicornia).* Animal food accounts for perhaps 25% of the diet in winter including small molluscs (Lack, 1986). Within the Mersey they are widely distributed across the central estuary with the greatest concentrations off the Ince and Stanlow Banks (see Figure 5b). Being dependent on open water or ice-free muddy areas, teal is particularly vulnerable to severe change in weather. Previous declines in teal numbers on the Mersey have been attributed to severe winters (Clark *et al.* 1990a & b), and local changes in food availability (Lack, 1986).

Dunlin

2.4.9 Following a British peak in the abundance of dunlin in 1996/97, there has been a continued decrease in the annual abundance levels for this species and in 1999-2000 dunlin were at their lowest abundance for 11 years and the annual index was the lowest since 1997-98. However large fluctuations, particularly at site level, are typical for dunlin because it is a highly mobile species. This variability has certainly been observed on the Mersey which, along with Morecambe Bay, has consistently been one of the two most important sites in the country for this species over the last five years. During the 1999-2000 period a large decline in the peak abundance was recorded in the Mersey and also at a number of other locations in the country (Morecambe Bay, Backwater, Thames and the Stour estuaries). However, the abundance levels recorded during these recent counts were still greater (by just under 10,000) than the levels quoted within the SPA citation. Within the Mersey the most important feeding sites for dunlin (see Figure 5a) are across the intertidal areas of Stanlow Banks, Dungeon Banks and the Frodsham Flats across the central region of the estuary (Pollitt 2001).

Redshank

2.4.10 The annual British index and the maximum counts for redshank were comparatively high for the 1999-200 winter period although the counts had shown a slight decrease over the previous year. Typically redshank have shown a reasonable degree of consistency at key sites although for the Mersey the winter maximum has shown a gradual increase from 1985/6 to 1997/8 followed by a decline over the two subsequent years (Musgrove et al., 2001). The north-west is an important wintering area for redshank from the breeding populations of northern Britain and Ireland. These birds are consistent in their use of autumn and spring staging posts and

wintering grounds (Batten et al., 1990). In 1990 (Clark et al., op. cit.) the Mersey was considered to be at/or close to its carrying capacity. However, since then redshank numbers have increased further and over the last five-year the abundances levels have remained in excess of the SPA citation values. This species occurs throughout the estuary (see Figure 6a) although the highest densities are found at Egremont and Rock Ferry towards the mouth of the estuary (Pollitt, 1999).

Pintail

2.4.11 At a national scale pintail have exhibited a general decline in abundance since a period of relative high abundance in the 1980's. In the 1999-2000 season the British maximum was the lowest since the late 1970's and was over 8,000 birds fewer than any of the previous three years. The annual index also fell to its lowest level since 1972-73.

2.4.12 In 1980-81, a peak count of 18450 pintail was recorded for the Mersey. Since then there has been a long, fluctuating, decline. In 1999-2000 (the latest data published) the peak count was 1,100 which is the highest value recorded for the last five annual counts (see Table 1). The decline in the Mersey has been part of a general decline in NW England, which was the species' stronghold although in recent years numbers have risen on the Dee roughly coincident with the numbers lost from the Mersey suggesting a regional redistribution of this species.

2.4.13 Pintail is a medium sized duck whose distribution extends around the entire northern hemisphere. The total population size is unknown but probably exceeds 5 million birds. The species is largely migratory, breeding in northern zones extending into the tundra (<50 pairs nest in Britain) and wintering in temperate and tropical zones. From mid-September, birds from Iceland, the Baltic, Fennoscandia and north-west Russia move south and west to over-winter, principally in Britain and the Netherlands. The highest numbers are usually present in Britain in December, the majority on estuaries in north-west England. Wintering pintail numbers have changed greatly over the last 30 plus years, increasing and then declining.

2.4.14 According to Prater (1981) *"extraordinary numbers on the Mersey have appeared since 1967-68 when a mere (though still significant) 1300 were recorded. Since then totals have increased steadily until in 1973-74 a massive 14800 were recorded. This may have been due to a redistribution of the north-west European population, caused to some extent by the changes of the Rhine delta area and with fewer birds wintering on the Atlantic coast of France. In subsequent winters this population in the north-west has spread to surrounding estuaries such as the Ribble, Dee and South Solway, with a drop to about 7000 on the Mersey. Since 1975 large numbers have again occurred on the Dee marshes where it was abundant many years ago."*

2.4.15 The decline in numbers wintering in Britain is paralleled by a decline in north-west Europe and thus, cannot be attributed to birds staying on the Continent over winter. According to Rose (1995), reporting the western Palearctic and south-west Asia waterfowl census 1994, north-west European pintail numbers have shown a shallow decline over the last 20 years, though this is not statistically significant. Nevertheless the threshold of international importance (calculated as 1% of the north-west European wintering population) was revised from 700 to 600 in 1996, reflecting an estimated population decline from 70,000 to 60,000 wintering birds. This is tentatively attributed to loss of breeding habitat rather than a decline in suitability of wintering areas.

Ringed Plover

2.4.16 At a national scale there has been a progressive decline in the annual index for this species since the late 1980's and this was continued during the 1999-2000 period (Musgrove et al., 2001). The Mersey was not recorded on a list of 'sites surpassing passage threshold' within the 1999-2000 and 1998-1999 WeBS reviews which would suggest that there has also been a major decline in the abundance of this species in this estuary during the autumn passage period. The most recent published passage count was for the 1996-97 period, and during this time a peak of 1,428 was recorded. This is equivalent to the abundances recorded within the SPA citations.

Turnstone

2.4.17 Turnstone is not a SPA qualifying species in the Mersey because historically it was recorded at low abundance levels. However, since 1996/97 they have been recorded in relatively high numbers and have consistently exceeded the international important abundance threshold (Musgrove et al., 2001). The 5yr average for this species from 1995/96 to 1999/00 was 1,067 and for the first time this has lead to it being identified in the WeBS annual review as being of international importance within the estuary (Musgrove, 2001). This 5yr average value was due to the presence, at peak abundances, of between 703 and 1,717 individuals between 1996-97 and 1999-00, although in 1995-96 only 2 individuals of this species were recorded.

2.4.18 This increase has been due to inclusion of counts taken at low water, which have shown that turnstone which usually roosts at North Wirral and on the Alt estuary immigrate into Mersey at low water to feed. Typically they forage in the outer estuary at Egremont and Rock Ferry (see Figure 6a) and hence, are included as a qualifying interest for the Mersey Narrows and Wirral Foreshore proposed SPA. This species was previously under recorded in this estuary because previous abundance estimates, including those quoted within the SPA citation were based on WeBS core counts that are taken at high water.

2.4.19 At a national level there has been a steady decline in the abundance of this species over recent years and during 1999-00 they were at their lowest abundance since 1984-85 (Musgrove, 2001). Compared against the higher abundances observed over the last five year, a decline in turnstone numbers was also observed in the Mersey during the 1999-2000 period (703). It is possible that this is linked to the construction of sea defences at New Brighton. This construction has according to Pollitt et al., (2001) had a detrimental impact on the habitat leading to siltation over turnstone feeding areas and evidently caused many turnstone to leave the area early during that winter period.

Black-tailed godwit

2.4.20 The annual British index and peak winter numbers of black-tailed godwit indicate a progressive long-term increase in the abundance of this species since the early 1970's and in 1999/00 they were three times greater than in 1972/73 (Musgrove et al., 2001). The winter maxima for the Mersey also dramatically increased (from 21 to 2,086) between 1993/94 to 1997/98 although it subsequently decreased in the following two winters. Due to this increase the Mersey qualified as internationally important for this species since 1996/97.

24.21 The black-tailed godwit which winter in Britain and Ireland are of the Icelandic breeding race *Islandica*, and numbers wintering in Britain have historically been related to breeding numbers in Iceland and prevailing climatic conditions of the time (Lack, 1986). The international population is estimated to have increased by 62% between the mid 1980's and 1998. It is this international increase which has been reflected in the Mersey SPA.

2.4.22 At low tide black-tailed godwit are quite widespread across the central region of the estuary although they are most abundant at Rock Ferry which lies towards the mouth of the estuary.

Wigeon

2.4.23 A particularly high peak abundance of 17,650 Wigeon was recorded in 1994/95 and this has resulted in the Mersey estuary having a five year peak mean in excess of the international threshold (12,500) in recent years. However, for the most recent five-year period (which excludes the 1994/5 count) they were recorded at levels below this threshold level and a relatively low value of 8,731 was obtained during the 1999-2000 survey period. As a result the most recently published five year mean for this species is 10,930 which is of national importance and, as per the SPA citation, represents 2.6% of the British population. This species generally favours the southern bank of the central estuary area and is generally found at highest abundances between Mount Mainstay and the Ince Bank/Frodsham area.

General feeding distribution

2.4.24 Waterfowl feeding takes place across all intertidal areas of the Mersey but it is evident from the above review that the most important areas, especially for SPA-cited species is across the intertidal flats of the southern and eastern sections of the inner estuary.

2.5 Sediment and Water Quality

2.5.1 The Mersey has historically received a high level of contamination for industrial effluents and sewage discharges and its has been one of the most polluted systems in Europe. This became evident in the 1960's and resulted in the implementation of a monitoring strategy to determine the extent of the problem. A clean up campaign initiated in the 1970's as well as the setting of Dissolved Oxygen (DO) targets (by the then North West Water Authority) and the enforcement of the Urban Waste Water Treatment Directive (UWWTD) have considerably reduced this pollution load (English Nature, 2001). From 1975 to 1995 the dissolved oxygen concentration continued to improve and the extent, duration and severity of the upper estuary DO sags were reduced. Nutrient concentrations also decreased over this 20-year period although the estuary remains hypernutrified (although without attendant symptoms of eutrophication). The long term historical changes in water quality conditions within the Mersey have been recently described using sedimentary cores taken from two salt marshes at Widnes Warth and Ince Marsh (Fox et al., 1999). These cores presented a geochronology of metal pollution levels and showed persistent increase in metal concentrations from the mid 9th and 20th centuries followed by improvements in subsequent years.

2.5.2 Despite these improvements, the quality of Inner estuary (Mersey SPA area) was most recently classed as poor (ULST, 1993) and indications are that it remains one of the most contaminated estuaries in the UK (Allen et al., 2000). Two reports commissioned by the Environment Agency provide information on trace metals (Pope et al., 1998) and the bioaccumulation of methylmercury (Langston et al., 1996). These studies both indicated that the Mersey was improving in quality although it remains widely contaminated by a range of metals.

2.5.3 Numerous studies have been conducted in the Mersey to describe the contamination levels in water, sediments and biota. The following illustrates examples of recently published studies along with a very brief summery of their findings: -

- PCBs in Mersey fish are 20-200 times higher than in the Atlantic Ocean or the Solway Firth and in some cases they exceed the limits identified by the US Environment Protection Agency (EPA) (Leah et al., 1997a).

- Mersey estuary is a net exporter of PCB's to the coastal environment and Liverpool Bay (Camacholbar VF, McEvoy J 1996)
- Evidence of Mersey flounder having been exposed to endocrine disrupters (Allen et al., 2000)
- Elevated levels of DDT in Mersey fish as compared with outer Liverpool Bay and Irish Sea (Leah et al., 1997b).
- High concentrations of organochlorines in mussels may have become biomagnified in Plaice and Dab within the estuary (McNeish et al., 1996).

2.5.4 It is in the light of such studies that, according to English Nature (EN 2001), the lethal or sub-lethal effects of toxic contamination of marine organisms and community disruption caused by the dominance of pollutant tolerant species remains a threat to Mersey estuary ecosystem health. The main risk would appear to be from acute pollution incidents and, as an example, there were bird mortalities following oil pipeline failures in 1989 and 1990. However, the chronic release of trialkyl-lead compounds, which were discharged from the Manchester Ship Canal, have previously lead to a build up in the food chain and this also lead extensive bird mortality in 1979. Legislation and effluent quality controls have prevented a reoccurrence of this incident, although lead levels in the environment are likely to still be high.

2.5.5 At present there is no evidence that chronic pollution in the Mersey is resulting in impacts to bird populations. The potential exists however for bird populations (as top consumers in the trophic chain) to be affected by the bioaccumulation of toxins or changes in the palatability or abundance of prey species, and EN consider this to be an issue which needs to be addressed. In particular contaminants can be bound up in the fine silts and clays of mudflats and saltmarshes and these could be sources of pollution if reworked. The contaminants that are most likely to be present in these sediments are: polychlorinated biphenyls (PCBs), pesticides, fertilisers and heavy metals (including tributyl tin, mercury and lead). Seepage from landfills (especially in the Ditton Brook area) is believed to result in high levels of mercury, lead, copper, cadmium and zinc within the sediments (Allen et al., 2000). These metals have been shown to drop out of suspension in the low salinity regions of the Mersey (Comber et al., 1995) thus contributing to the sediment contamination loads of the upper estuary.

2.5.6 Conversely there is also the risk that improvements in water quality as a result of UWWTD could have impacts upon bird populations by reducing prey abundance and the carrying capacity of mudflat. Once again the effects are difficult to predict. As noted by EN (2001) the EA will be responsible for determining whether impacts to the integrity of European Marine sites occur as a result of this process and research is being conducted jointly by EN/CCW and EA on the relationship between organic nutrient and birds.

2.6 Invertebrate Communities and EA Survey Results

2.6.1 For the purposes of the Environment Agency consents reviews there is a need to understand the value of the intertidal habitats as feeding sites for waterfowl. For this reason the Environment Agency carried out a survey of the invertebrate communities in the Mersey during August and September 2001 (as described in Section 1.2). The results of this survey are presented as Appendix 3 and in this section these results are reviewed and compared against those from previous Mersey estuary surveys.

2.6.2 Of these previous surveys possible the most comprehensive information on the invertebrate communities is provided by from the results of a detailed programme of invertebrate and seed sampling was undertaken by Environmental Resources Ltd during the winter period of 1990-

91 and 1991-92. These surveys were undertaken on behalf of BTO and were designed to provide a baseline description of the Mersey estuary against which the potential impacts of the then proposed Mersey Barrage could be assessed. The data obtained were reviewed in two BTO studies (Rehfisch et al., 1991 and Holloway et al., 1992) which sought to identify the links between the distribution of feeding waterfowl and invertebrate prey species. For these two studies the results of the detailed ERL invertebrate studies were summarised and for this report the results of the Environment Agency's 2001 summer surveys are compared against these summary data. For more detailed between-survey comparisons the full results the ERL survey can be obtained from McGill et al., (1992).

2.6.3 For the BTO studies the distributions of six waterfowl species (shelduck, teal, pintail, grey plover, dunlin, curlew and redshank) were compared these against infaunal characteristics at 18 intertidal locations. From the statistical comparison of the waterfowl and invertebrate datasets (based on regression analyses) no link could be drawn between the distribution of pintail, grey plover, curlew and redshank and the invertebrate prey species. This was true for both the spatial distribution of these waterfowl species and the between-year differences in their abundance (for the 1990/1991 and 1991/1992 winter periods). The distributions of shelduck and dunlin were however, partly explained by comparison against the log-transformed values for total invertebrate biomass and total oligochaete biomass with the former value being heavily influenced by the latter due to the high proportion of oligochaetes within the invertebrate communities generally. The distribution of teal was partly explained by the log-transformed values for total invertebrate, oligochaetes and *Macoma balthica.*

2.6.4 A summary description of the invertebrate communities recorded during these BTO surveys is presented in Table 2 along with results from the Environment Agency surveys and, for comparison, some results from previous Young Associates studies which describe intertidal communities in two other north west estuaries (Dee and Morecambe Bay). In addition, the survey areas that were sampled for the BTO surveys are illustrated in Figure 7 and the total abundance and number of taxa in the areas from the BTO 1990/91 surveys (Rehfisch et al., 1991) are shown in Figure 8. It should be emphasised the data from these surveys are not strictly comparable because they have been collected from different sites, for different objectives and at different times of the year. However, using this information to provide a qualitative regional and temporal context, and multivariate analysis to describe the spatial community patterns, the following section reviews the Environment Agency survey data.

Results of Environment Agency benthic survey

2.6.5 The number of invertebrate organisms (estimated as abundance per m^2) and taxa in the Environment Agency benthic samples are illustrated in Figure 9. These plots show that in overall terms the samples that were taken during Environment Agency survey had relatively low numbers of organisms and taxa and therefore, they describe relatively impoverished communities across much of the area surveyed. For instance, in 12 of the samples (Site numbers: - 7, 24, 26, 28, 30-32, 35, 38, 40, 41 and 49 which represents 23% of the samples taken) no organisms were present at all, and in one sample (Site 14) only a single mysid (not strictly a benthic species but a pelagic 'shrimp like' crustacean) was present.

2.6.6 These sites were almost all located in areas of sand substrata (except Site numbers 28 and 40 which were muddy sand and sandy mud respectively) where a lower abundance of infaunal species is to be expected due to the mobile and dynamic nature of the environment. Three of the sites with highly impoverished communities were situated on the sandflats at Hale Head (east of survey area) and this area is likely to be affected both by scouring from strong currents and by the physiological stress imposed by salinity variability in this region. Many more of the sites with no fauna were situated across Eastham Sands and in the Garston

Channel and typically these sites were situated in the sublittoral and low shore regions which will also be subject to heavy scouring by tidal currents. These sites may also be impacted through regular inundation and burial of sediments as a result of channel movements and from the deposition of sediments imported into the estuary.

2.6.7 To describe and compare the invertebrate communities at the other 41 sites, multivariate analysis was undertaken. The results of this analysis, in the form of dendrogram classification and MDS ordination plots (created following analysis of a root-root transformed species abundance matrix) are shown in Figure 10 and 11. These outputs are used to group the sites according to their species composition and community structure. The different 'Community Groups' that are identified from this analysis are indicated on these figures and, to show their spatial relationship, they are also shown on a chart of survey sites in Figure 12.

2.6.8 Five community types were distinguishable on the dendrogram plot at the 10% Bray Curtis similarity level. These are labelled 1 to 5 and, of these, Groups 1, 3, 4 and 5 (representing 20 sites in total) had impoverished communities that were characterised by species that are typically recorded in clean well swept sands in low shore and shallow sublittoral areas. It is clear therefore that, as for the samples which included no fauna, these sites are also subject to impacts from sediment movements and tidal flows. The division of these 20 sites into four community types following the multivariate analysis reflects only slight differences between the sites in terms of the particular species that are present. In summary the key species and community characteristics of each these four groups are as follows:

- Group 1: - Set of 11 sites mainly situated to the west of Garston rocks with impoverished communities with only between one and four taxa per site. The taxa present were usually, *Haustorius arenarius* (amphipod), *Eurydice pulchra* (isopod) and *Gastrosaccus spinifer* (mysid) which are all crustaceans that are typically recorded in estuarine sands (the latter two are free swimming rather than typically infaunal species). The total abundance of all species at these sites range from just 10 to 300/m^2.

- Group 3: - Set of 6 sites distributed in the across the eastern regions of the estuary at which only occasional *Bathyporeia pilosa* (a typical intertidal and opportunistic amphipod species) was recorded.

- Group 4: - Site 45 alone at which only one *Nephtys* juvenile was recorded.

- Group 5: - Sites Site 18 and 23 at which just one and two *Spio martinensis* were recorded respectively.

2.6.9 By contrast to these species-poor sites, the sites in Group 2 had a richer estuarine community characterised by key waterfowl prey species such as *Macoma balthica*, *Tubificoides benedenii*, *Mytilus edulis*, *Nereis diversicolor* and *Corophium volutator*. However, even at these sites the total abundance of species was often relatively low (30 to 800/m^2 at most sites) although there were slightly higher numbers at locations where small aggregations of mussels are recorded (e.g. 1,800/m^2 at Site 34 and 1480/m^2 at Site 5).

2.6.10 By contrast, at six of the Group 2 sites, all of which were located in areas with a mud substratum and were usually located on the upper shore, there was a relatively balanced community with relatively high abundances of infauna (3,400 to 16,700/m^2). These were at the following sampling locations: Sites 19 and 25 along the north bank in the lee of Garston Rocks and on upper shore in front of Liverpool Airport, Site 2 in a shallow sublittoral mussel

bed habitat in front of Rock Ferry terminal and Sites 39, 51 and 52 on mudflat habitat near Mount Mainsty (see Figure 12).

2.6.11 In summary therefore, these results describe a typical pattern for estuarine invertebrate with habitats of relatively species-poor communities over large areas, particular the sand flats and tide swept channels, but richer communities and more abundant waterfowl prey resources in the settled depositional areas and mudflat habitats.

Comparison with previous surveys

2.6.12 As a large proportion of the samples had little or no organisms the average abundance levels for key invertebrate species (as shown in Table 2) were low relative to the previous BTO studies. In particular the abundance of oligochaete was particularly low which is relevant in this case because of the known link between the distribution of oligochaetes and waterfowl feeding activities (Holloway et al., 19992). This difference between the two Mersey benthic surveys is largely a symptom of the differences in the sampling regime and reflects the fact that the BTO surveys concentrated more heavily on describing communities at known waterfowl feeding sites where richer communities would be expected.

2.6.13 The abundance levels for the Environment Agency surveys were also low in comparison with samples taken in the Dee and Morecambe Bay and were instead only compatible with the inner Dee site which was a heavily scoured sandflat of limited value as a feeding ground for waterfowl (Young Associates 2000). Once again this will be due to the sampling regime for the Environment Agency survey and the large number of sites with low numbers of organisms.

Table 2 Abundance (m^2) of invertebrates for the Environment Agency summer 2001 survey compared against previous estuarine surveys in the Mersey and North West.

Site	Mersey	Mersey	Mersey	Outer Dee	Inner-Dee	Morecambe Bay -Sand	Morecambe Bay -Mud
Date	Summer 2001	Winter 90/91	Winter 91/92	June 1994	January 1999	November 1998	November 1998
Data Source	EA 2001	BTO 91	BTO 92	AERC 94	YA 2000	YA 99	YA 99
H. diversicolor	34	154	249	920	358	7	18
Oligochaeta	483	10497	15937	54690	247	85	18745
C. volutator	230	271	1330	32820	259	43	134
H. ulvae	34	51	267	2180	6	2014	6765
M. balthica	97	108	292	2140	21	932	720

2.6.14 This survey approach has provided the intended 'broad brush' description of the Mersey estuary habitats and has provided a focus for the ongoing assessment work. The resulting description of the invertebrate communities correlates well with what is known about the distributions of feeding waterfowl (with the richest sites being located in key waterfowl feeding sites in the middle reaches of the inner estuary) and the survey results can be used to prioritise the regions in which ongoing monitoring and assessment work can concentrate.

3. CONCLUSIONS AND RECOMMENDATIONS

3.1 Summary

3.1.1 From this review it is evident that a large amount of information, survey data, interpretative reports and published papers are available that describe the ecology and physico-chemical characteristics of the Mersey estuary. A total of over 330 relevant documents have been compiled in the accompanying database (these are listed in Appendix 4 along with a pie-chart describing the key sources for these documents) and it is likely that many more publications will be identified and added to this bibliography following further consultations with stakeholders. Indeed, as discussed below, regular consultations, additions and edits to this database will be essential if it is to remain a consistently relevant source of information and an effective management tool.

3.1.2 A large proportion of the available information describes the hydrodynamic regime and geomorphological characteristics of the estuary and the adjacent coastline because many modelling and coastal monitoring studies have been undertaken to inform activities such as vessel navigation, dredging and sludge disposal. This information has also been obtained to support specific development proposals of which probably the most significant (in terms of the data obtained) is the Mersey Barrage scheme.

3.1.3 A large amount of data is also available to describe the waterfowl populations following the long term monitoring that has been carried out as part of the WeBS scheme and its precursor BOEE (Birds of Estuaries Enquiry). Also, because of the intense concerns over pollution levels, and a need to understand the efficacy of the estuary clean up programme, the water and sediment quality conditions have also been consistently monitored.

3.1.4 This available information has been reviewed in a number of documents which provide useful summary descriptions of the estuary's ecology. Of these the most recent and useful is the English Nature Regulation 33 advice document but there are also a number of older documents such as: The Dee and Mersey Environmental Background report (Rice and Putwain, 1987); the Mersey Estuary Management Plan (ULST, 1995) and 'The Mersey Estuary Naturally Ours' (Mersey Estuary Conservation Group, 1995). The latter document has also been updated and will be reissued in Summer 2002 (Baker-Schommer, pers comm.).

3.2 Long Term Strategic Objectives

3.2.1 The available data for the Mersey and the summary documents listed above confirm that we have a very good understanding about the waterfowl interests and the physico-chemical conditions of the estuary along with a qualitative understanding about how these factors interact. This qualitative understanding is based on a general scientific knowledge of ecological processes as well as observations of the historical trends in the Mersey over the last few decades. What is lacking however is a quantitative understanding about these interactions and particularly of the effects that changing levels of water contamination have at the top tropic levels (especially waterfowl species). Such an understanding would be needed to directly, and unequivocally, relate the effects of detrimental water quality impacts (or indeed improvements arising from implementation of the UWWTD - see next paragraph) to the consequences for SPA interest features.

3.2.2 The need for this information is recognised in the English Nature Regulation 33 advice document (EN 2001) which identifies the following key issues as requiring further investigation in the Mersey: -

- **Potential effects of cleaning up the estuary in response to the UWWTD** - The reduced organic loading in the Mersey could cause a redistribution of birds in response to changes in the abundance and distribution of intertidal invertebrate species. EN note that if significant effects are likely from such activities then the Environment Agency will need to produce an Appropriate Assessment to test the scale of the effects and determine whether there is an adverse effect on the integrity of the site.

- **Ecological impacts from chronic pollution and contamination loading of sediments.** While EN concluded that there is presently no evidence of chronic contamination impacts on bird populations in the Mersey estuary, this is an issue that they believe needs to be considered further.

- **Evidence of the species and ecosystem-scale impacts of endocrine disrupters.** The Mersey is believed to be a 'high priority for further research in this field (Allen et al., 2000; English Nature, 2001).

3.2.3 To this list from EN could be added the following study based on the findings of the present review:-

- **A detailed review of information (allied to field investigation) on the relationship between sediment contamination and infaunal communities.** As the sediments of the Mersey retain a large proportion of historically discharged contaminants these will continue to be a key source of contamination over future years. Therefore, there is a need to more closely investigate the interactions between sediment quality and the diversity and abundance of invertebrate communities. A better understanding of this interaction, allied to our already good understanding of the effects of physical sedimentary changes, would enable the Environment Agency to better predict, and monitor, the biological consequences of any alterations to the sedimentary physico-chemical regime. This information could also be used to develop EQSs for sediment quality. It remains the case that the UK has no formal sediment quality standards (Cole et al., 1999) and these could be developed such that it is possible to more accurately gauge ecologically detrimental impacts based on measurements of sediment contamination. A good source of information for such a study is likely to be the NRA R&D note 230 which reviews the 'effects of sediment metals on estuarine benthic organisms' (Langston et al., 1994).

3.2.4 These strategic studies will each require intensive research and development work and could most usefully, and cost-effectively, be applied at a national level. This is the case for the study of impacts arising from reduced organic loading following implementation of the UWWTD which is evidently already subject to review as part of a joint English Nature, Countryside Council for Wales and Environment Agency project (EN 2001). In most cases the Mersey estuary, given its history of pollution, would be a prime case example for any such national studies and therefore, it is likely that these large-scale projects will provide further information about this particular estuarine system.

3.3 Short term management objectives

3.3.1 While the above listed strategic studies will clearly be advantageous to the general management of UK estuaries it must be recognised that precisely defining the cause and effect relationship between contamination levels and ecological impacts along the trophic pathways will be complex, costly and will take time. Moreover, there is a possibility that they may not provide the results needed for site-specific management of estuaries such as the Mersey. Therefore, more practical management and assessment solutions are required in the

interim. These should be based on ensuring adherence to existing pollution controls (as required under IPPC, Dangerous substances, UWWT directives, as well as Habitat Regulations) and target setting by using existing Water Quality Objectives and Environmental Quality Standards (EQOs) and also developing new and directly applicable, site-specific Ecological Quality Objectives (EcoQOs). The efficacy of using water quality management measures and target setting, without a quantitative understanding of the contamination-impact relationship, has been proven through the improvement in the ecology of the estuary that has taken place in recent years through this precise approach. Furthermore, the Ecological Quality Objectives can be specifically developed in such a way that they underpin the conservation objectives identified by English Nature, under Regulation 33 of the Habitats Regulations (EN 2001). This is likely to ensure that there is an integrated approach to the monitoring and management of the Mersey Estuary SPA (and the Wirral Foreshore and Mersey Narrows pSPA).

3.3.2 However, a more detailed knowledge of the current and historic water and sediment quality conditions in the Mersey estuary is required to inform this target setting process. Therefore, the following tasks are recommenced as priorities for the ongoing survey and assessment work: -

- **Conduct a specific review of the Mersey estuary's water quality status to act as a baseline for all future assessment and monitoring work.** The most recent information sourced for this review and for the EN advice under Regulation 33 was from 1993 (ULST) and 1995 (NRA). Therefore, there is a need for a specific water quality review which draws upon information collected in recent years and acts as a baseline for ongoing assessment work. A new review is evidently being prepared (P. Jones pers. comm.) and the findings of this should be considered before commissioning any further work in this field however it is likely that a desk based review followed by field survey work will be needed.

- **Conduct a specific review of the Mersey estuary's sediment quality status to act as a baseline for all future assessment and monitoring work.** In the same way that a water quality review is required, there is a need to obtain an up-to-date record on the sediment bound contamination levels. As with the water quality evaluation the first stage should be a review of existing data and information of which there is believed to be a large amount (e.g. a long term data set is held by Zeneca Ltd)

- **Develop simple model/budget for the Mersey.** To provide a context for the assessment of inputs, discharges and abstractions it would be valuable to have in place a simple model for the estuary which describes the balance of inputs to the estuary against the rate of release into coastal waters. This could be used to indicate the net loading in the system and might be valuable for determining in-combination impacts from multiple activities (discharges, abstractions etc.). Production of such a model would require information on the length of time that released contaminants are retained within the system as well as other hydrodynamic information which should be readily available given the extensive amount of work that has been done in this area for the Mersey estuary. This work could draw upon the results of a number existing studies on contaminant and water fluxes within the Mersey such as: Cole and Whitelaw (2001), Lane e al., (1997) and Wither et al., (in press).

- **Identify a monitoring scheme.** There is a need to identify a simple and effective monitoring scheme for the Mersey estuary in order to provide a context for the ongoing management of the estuary. For this there should be a clear division of labour between

English Nature, who will be responsible for monitoring the biota, and the Environment Agency, who will need to concentrate on reviewing water quality and sediment quality conditions. Liaison between the two parties will be valuable to ensuring that there is compatibility between the two monitoring programmes and also no unnecessary duplication of survey effort and costs. For example it would be valuable for standardised sampling locations to be established and used for both the EN and EA monitoring programmes.

3.4 Database and options for its ongoing development

3.4.1 It is hoped that the database that has been produced for this study will prove to be an effective tool in the ongoing management of the Mersey estuary and specifically for the Regulation 50 consents review that the Environment Agency will pursue. The database has been set-up in such a way that it can continue to be updated and revised by Environment Agency and added to by all end-users. The extent to which it is utilised and revised in this way will ultimately determine whether is becomes a fully comprehensive product and thus a valuable management tool. There are also options for the ongoing development of this database which will help to guarantee its continued value and applicability over the long term. Four such options are presented below.

Regular circulation to stakeholders and contributors.

3.4.2 To ensure that it is updated it is recommended that the database is regularly sent to potential contributors and, vice versa, that contributors supply the Environment Agency with updates. In this respect it is intended that a copy of it will be forwarded to all those parties who contributed to its production and provided consultation response as part of the review process. It is hoped that this circulation process may prompt further contributions from the recipients although clearly any new information will need to be forwarded to the Environment Agency to ensure that the core database is updated. Recipients will be requested to do this as part of the circulation process.

Place a version online

3.4.3 A more effective method for ensuring that the database remains permanently updated (compared with regular circulation described above) would be to pursue mechanisms for its online dissemination. This would ensure that there is a single database that can be accessed by all contributing parties. A good model for this is the 'Dorset Marine Literature Database' (www.dorsetcoast.com) which has been established to facilitate the dissemination of information on Dorset's Marine environment. This site comprises a very user-friendly interface that allows the database to be searched by: - 'key word', author or date of publication and also includes a mechanism for adding new records to the list.

Link online version to other website database lists

3.4.4 To further promote the Mersey metadatabase, and thus ensure that it is used, it would be particularly useful to add it to any relevant literature source lists. A good example in this case is the 'EreFS' initiative which has been set up by the Estuarine Research Federation. This initiative involves the collation of literature search outputs which are either location-based (e.g. Baltic Sea) or topic-based (e.g. sediments). These lists are again accessible online (www.erf.org). It is hoped that similar UK-based literature source lists will be, or have been, developed to which the Mersey metadatabase could be added.

Link to raw data

3.4.5 It is possible for metadatabase in its current form to be linked to the raw data sets and survey results for a listed publication (e.g. the bird counts that underpin a review of waterfowl

populations). The advantage of this is that it would enable all database end-users to interpret and review the original data for their own particular studies. This would involve inserting an 'OLE' link into the database alongside the relevant document citations which, when clicked, can open the raw data in whatever format it has been stored in. The raw data would have to available in digital format and would need to be stored alongside the database.

3.4.6 The disadvantage of this approach is that it will increase the size of the database and will result in it operating at slower speeds. However, it may be a valuable to adapt this approach for in-house use on the Environment Agency network where it will be easier to handle this larger linked document. In particular there may be a need to include those raw data sources that are identified as being critical for the Regulation 50 consents review and which may need to be regularly referred to.

4. MERSEY ENVIRONMENTAL METADATABASE GUIDE

4.1 Introduction

4.1.1 The accompanying metadatabase has been prepared using Microsoft MS Access 97 and includes a list of published and unpublished documents that provide information on the environmental characteristics of the Mersey estuary. This list covers studies that relate exclusively to the Mersey as well as those which have included reference to the Mersey as part of broader regional studies or investigations covering a number of estuarine systems. The first version of the database contains around 330 references but it is hoped that this will continue to be extended over time (see Section 3.2).

4.1.2 The information presented for each of the references listed is as follow.

- **Title**: The full title of the documents
- **Reference Type:** Whether the document is a book, academic paper, University thesis etc.
- **Information Source:** The full citation for academic publications or just the company or authority that produced the document and from whom it may be possible to obtain a copy.
- **Author/Contact**: Author(s) or Editor(s) of the document or, where relevant, the company or authority that produced it.
- **Year**: Year of publication
- **Keywords**:. One or more words (selected from a pre-defined list – see below) which are relevant to the document and can be used to select it out based on its subject matter.
- **Creator of Record**: Details about the person/company/organisation who entered the reference to enable all additions to be traced.
- **Area of Study**: Describes the areas covered by the relevant study (e.g. the Narrows, the Mersey Estuary or Liverpool Bay).
- **Comments/Summary** - Possible the most valuable aspect of this database this section can be used to summarise the findings of the particular study or to include any other comments that are relevant.

4.1.3 Details about how to use this database are presented in the following sections and the key methods for interrogating the database are also shown in Figure 13.

4.2 Opening and using the Database

4.2.1 The database has been set up to allow all users to view the bibliography, make search enquiries queries, print out search result reports and add new references as required. However, general users are not able to view the database table or edit existing components of the database. This can only be done by the database manager and any other individuals who have the requisite password permissions.

4.3 New Record

4.3.1 To add a new record simply click on the relevant button in the bibliography and add the text within the relevant field windows. A minimum number of fields need to be completed for a new record to be accepted and these are indicated by bold text in the field titles. The minimum number of fields that need to be entered are: title, publication source/reference, author/contact and the creator of record. The latter entry is important as it will enable the

database manager to identify who has used the database and the source of the relevant new entry.

4.3.2 General users are not able to edit existing records, so where edits are required a user should add a completely new record. The database manager will then be responsible for checking at intervals that there are no duplications.

4.4 Searching database

4.4.1 There are numerous ways to search the database for specific references or subject areas. Some examples are listed below and are illustrated in Figure 13.

- One way to search the database is to click the 'Select Search Criteria' button on the bibliography form and then add the relevant search criteria within the relevant field (e.g. year, author) and/or select a relevant keyword.

- An alternative approach is to right click within the relevant field on the bibliography form and type the criteria in the 'filter for' box. Criteria must begin and end with an asterisk and can be partial (e.g. *197* within the year field to view all information from the 1970's) or complete words or numbers (e.g. *waterfowl*)

- Also it is possible to search by a word, number or phrase already visible on the screen by highlighting it, right clicking and selecting 'filter for selection'

4.5 Key Words

4.5.1 To separate the references into categories the following 58 words or phrases have been identified as key search words. *Arsenic, Bacteria, Benthos, Bioaccumulation, Fish, Birds, Cadmium, Zinc, Arsenic, Carbohydrates, Chromium, Coastal Protection, Development, Ecology, Fish, Fisheries, Groundwater, History, Hydrology, Inorganic, Invertebrates, Lead, Leisure, Macroalgae, Management, Management Plan, Meiofauna, Mercury, Mersey Basin Campaign, Metals, Nickel, Lead, Chromium, Nutrients, Oil, Organic, Organochemicals, Oxygen, Physical, Phytoplankton, Phytoplankton, Plants, Pollution, Pollution Control, Radionuclides, Salinity, Saltmarsh, Sea level rise, Sediments, Sewage, Shellfish, Shipping, Socioeconomic, Tidal Currents, Titanium, Turbidity, Water Quality, Zooplankton.*

4.5.2 For any new records that are entered, one or more of the above listed words or phrase should ideally be added within the 'Key Search Words' field.

4.6 Report production

4.6.1 To print a list of the references in the bibliography or the output from a specific search simply click on the 'View Search Report Button'. Note that to print this Access document it may only be possible (in some cases) to right click on the screen and then select the print function.

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FIGURES

The Mersey Estuary

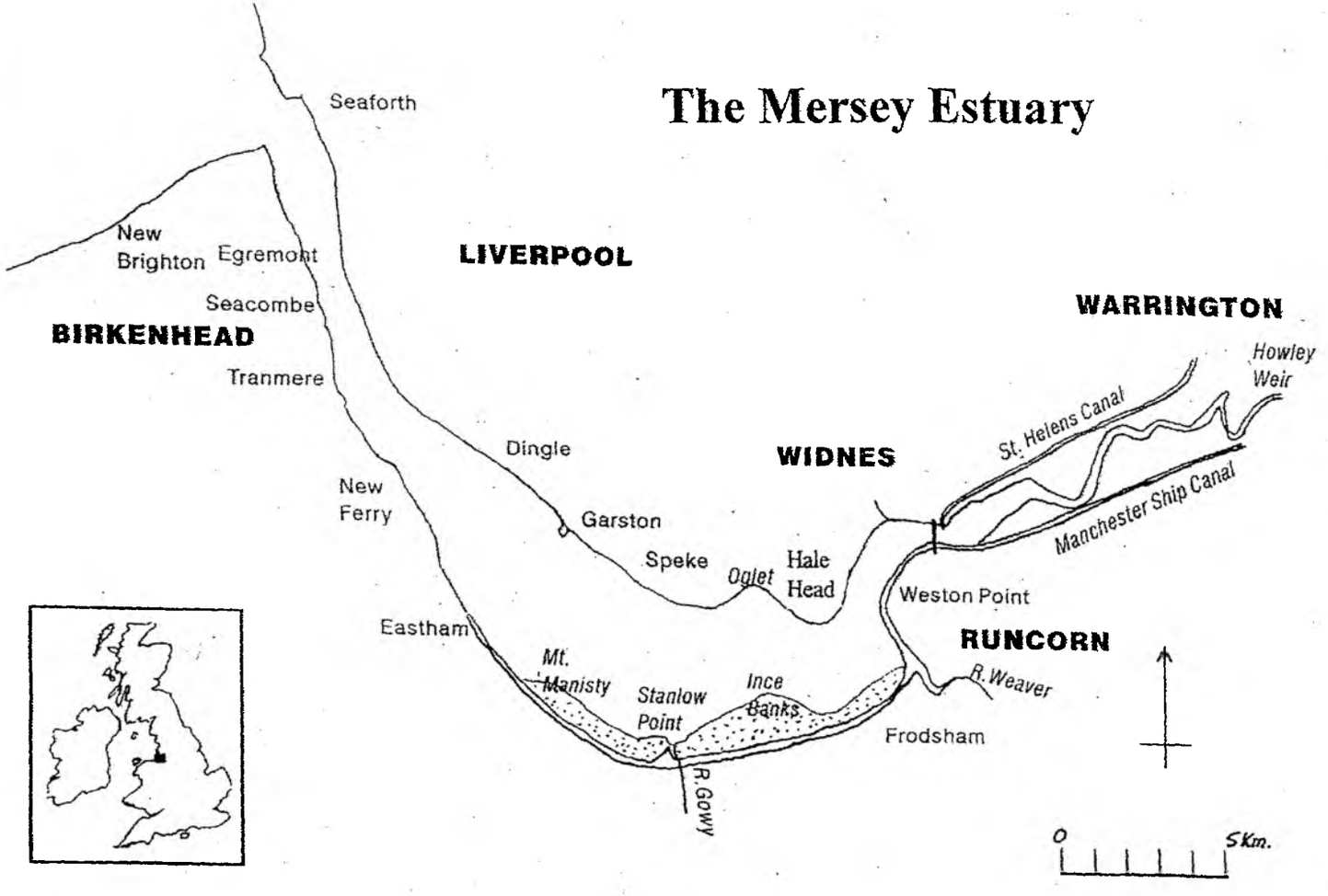

Figure 1

Project Title: Mersey Estuary Baseline Biological Survey.
Title: Map showing the location of key sites along the Mersey Estuary.

Project: A3602

Reproduced from - The Mersey Estuary - Naturally Ours (The Mersey Estuary Conservation Group, 1995)

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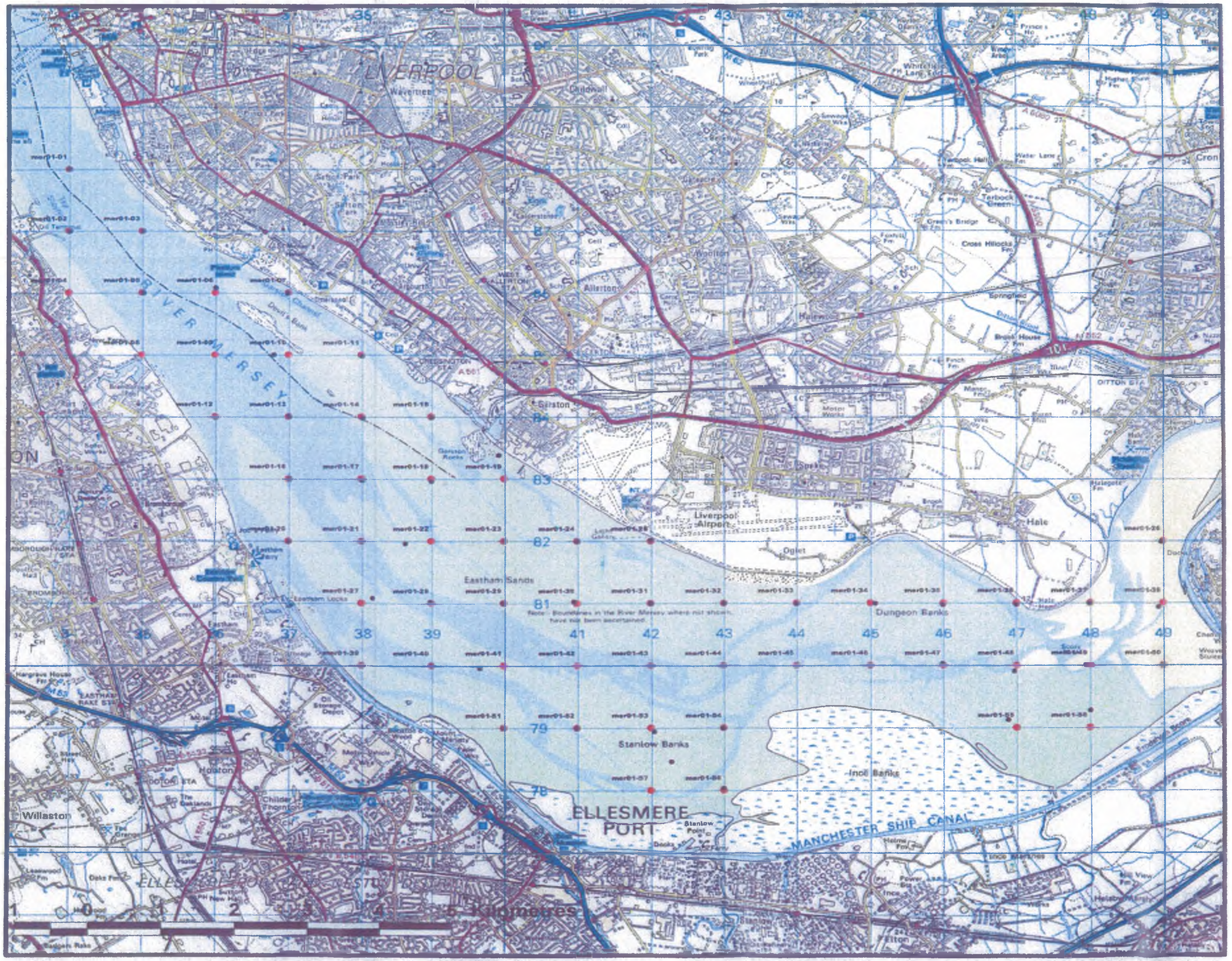

Figure 2

Project Title: Mersey Estuary Baseline Biological Survey

Title: Location of sampling sites for the Environment Agency's benthic survey (August and September 2001).

Project No.: A3602

Key:

- Proposed sampling site
- Position at which sample was taken

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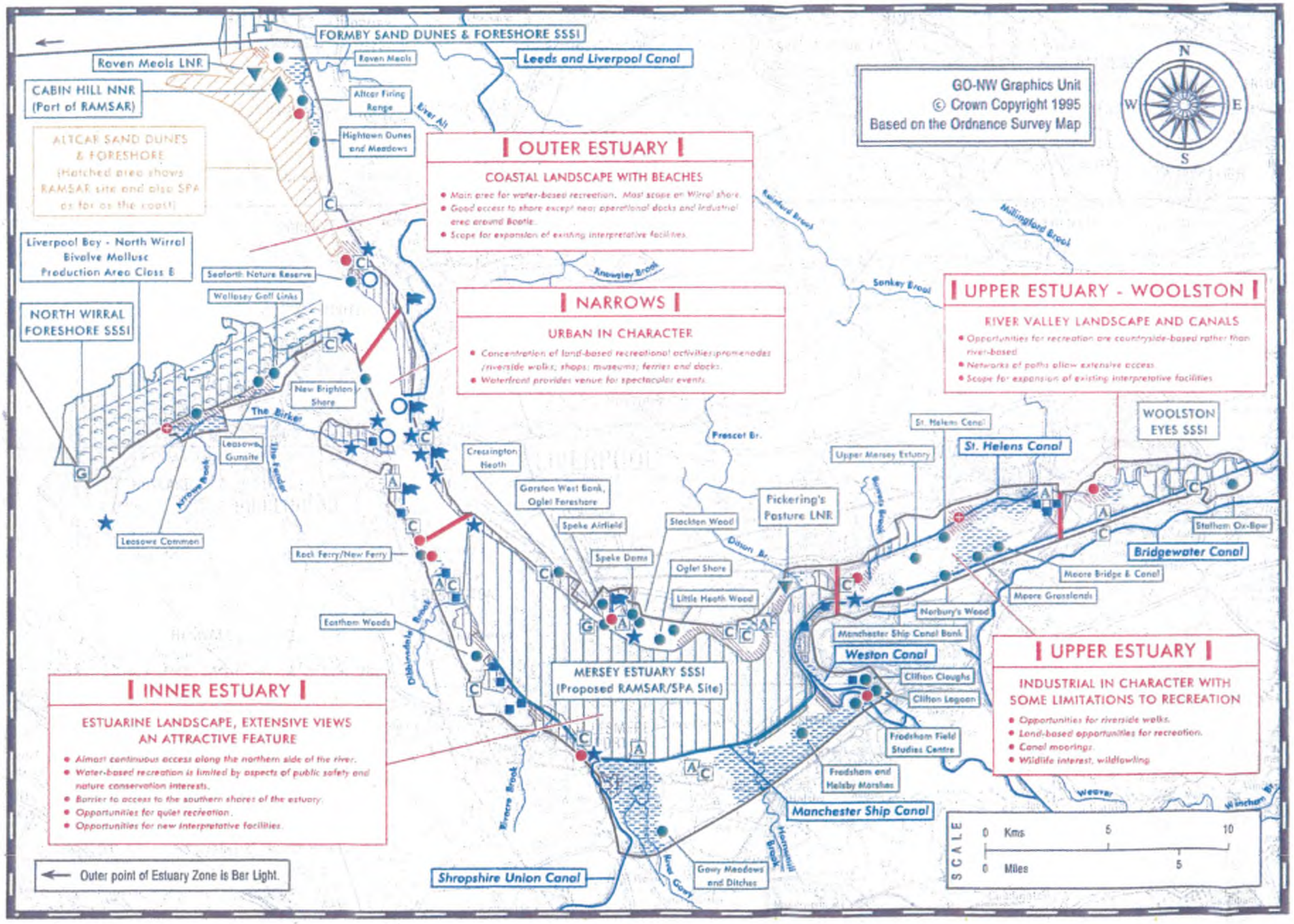


Figure 3

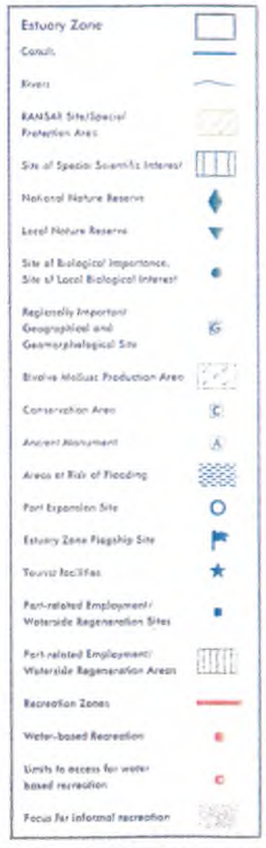
Project Title: Mersey Estuary Baseline Biological Survey

Title: Map showing key socio-economic and environmental features and sites of importance in the Mersey (MEMP 1995).

Project No.: A3602

Reproduced from the Mersey Estuary Management Plan (ULST, 1995)

Key:



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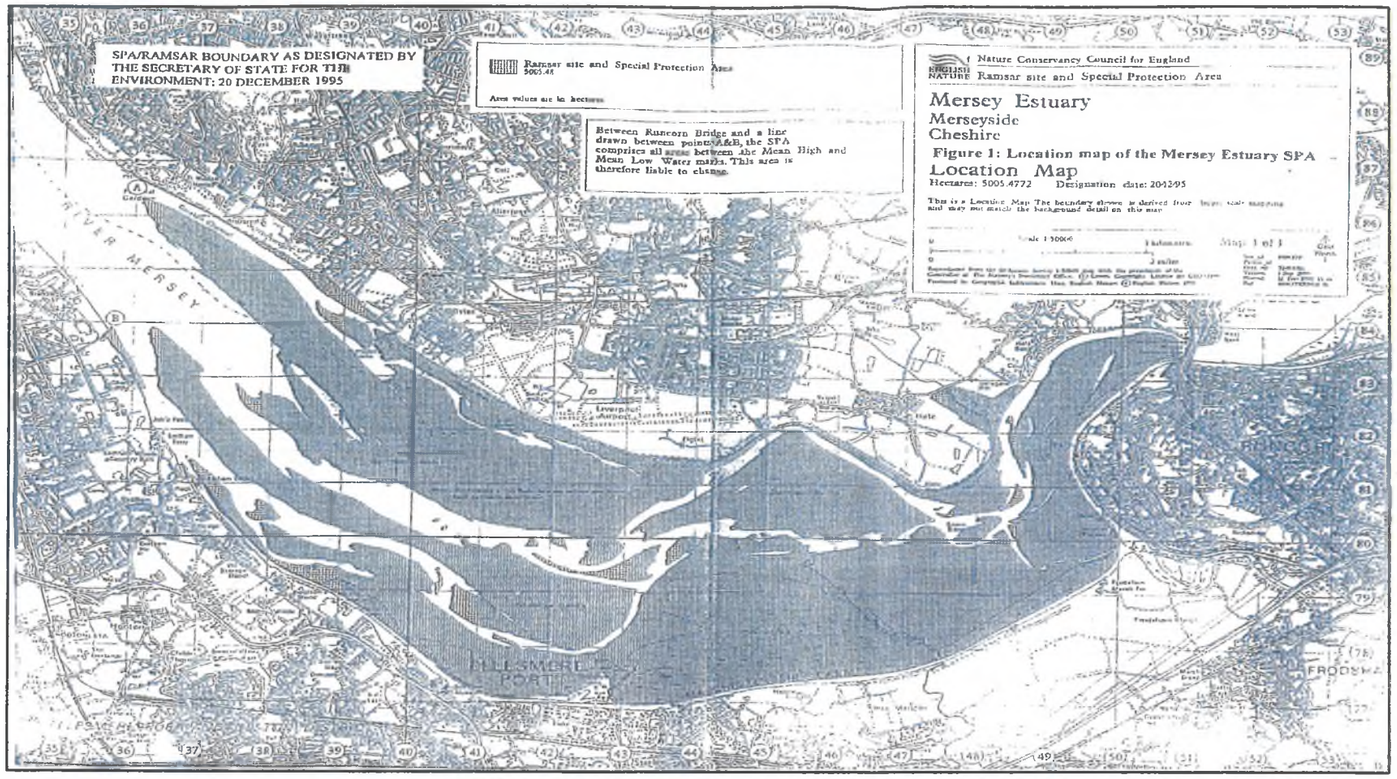

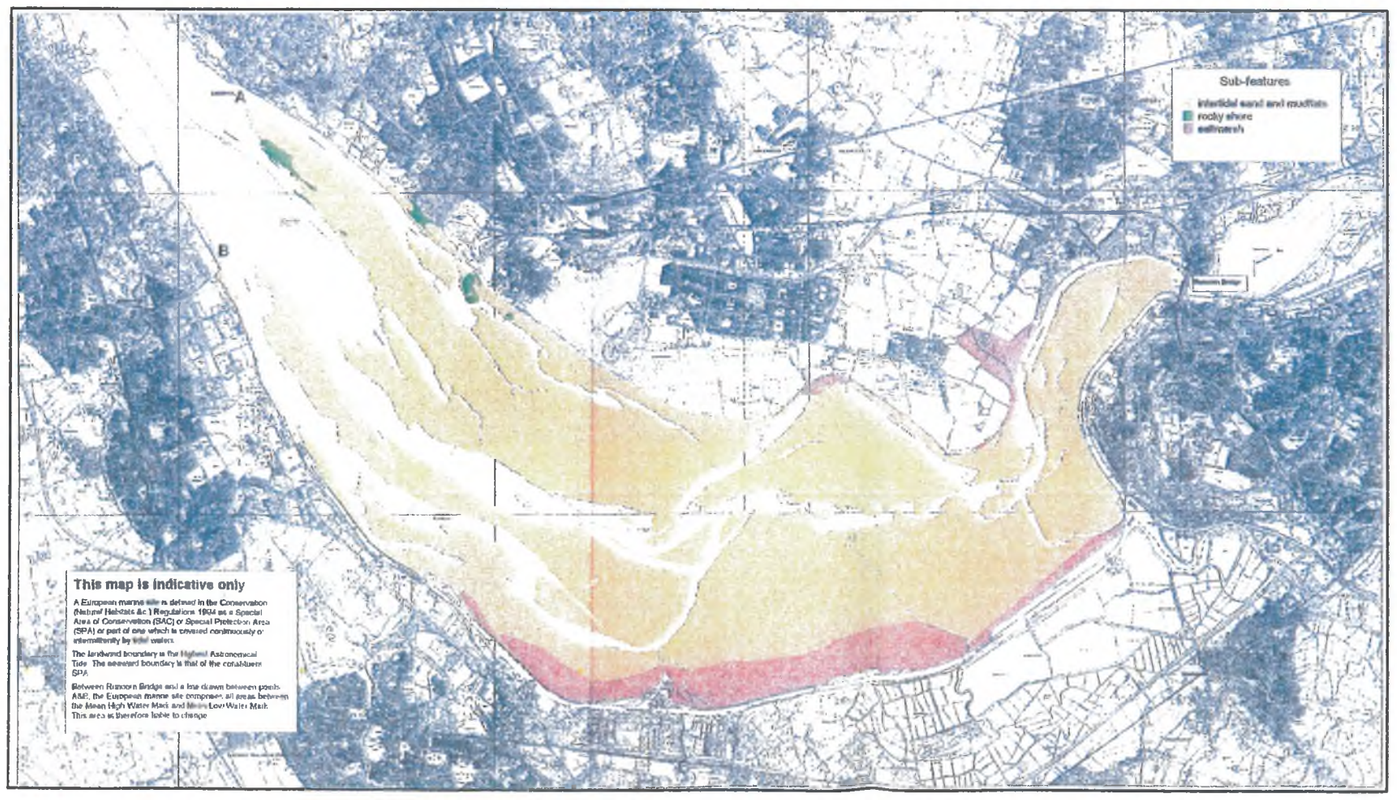

Figure 4

Project Title: Mersey Estuary Baseline Biological Survey.

Title: Boundaries of the Mersey Estuary SPA and distribution of key habitats.

Project No.: A3602

Notes

Reproduced from Mersey Estuary European marine site (English Nature, 2001)

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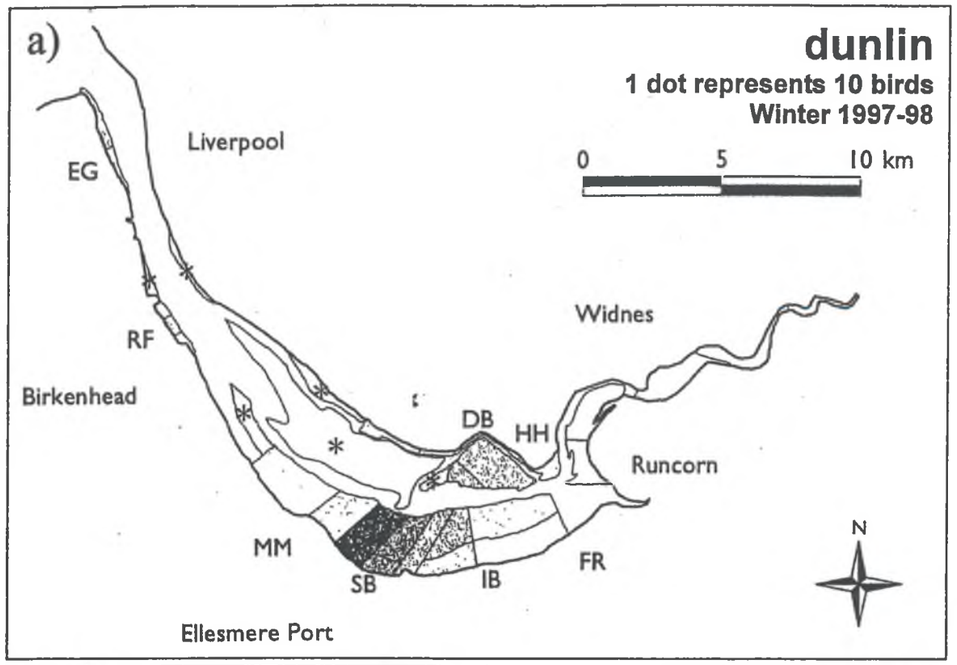

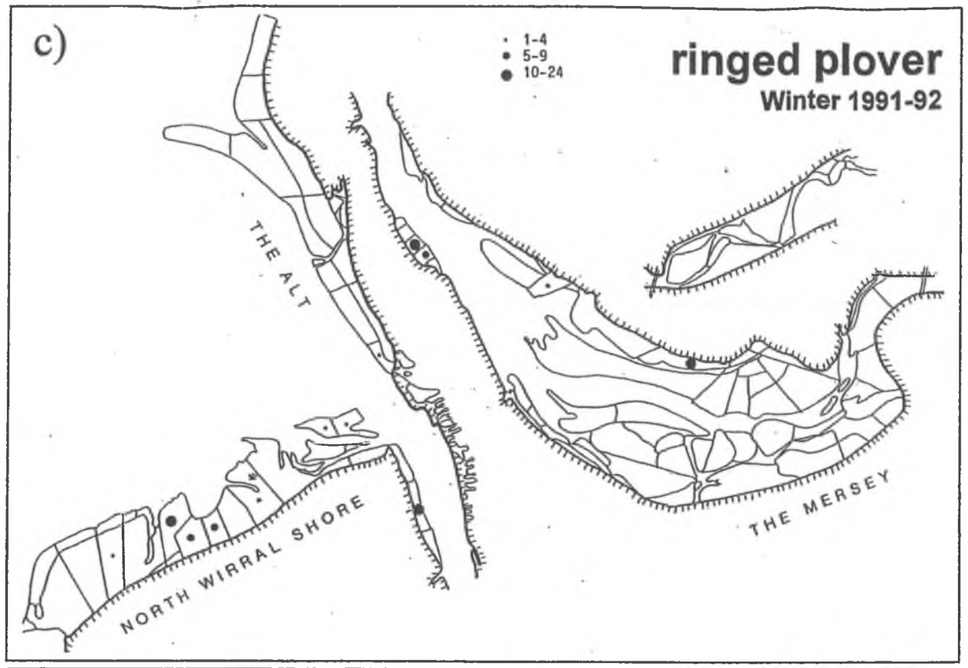

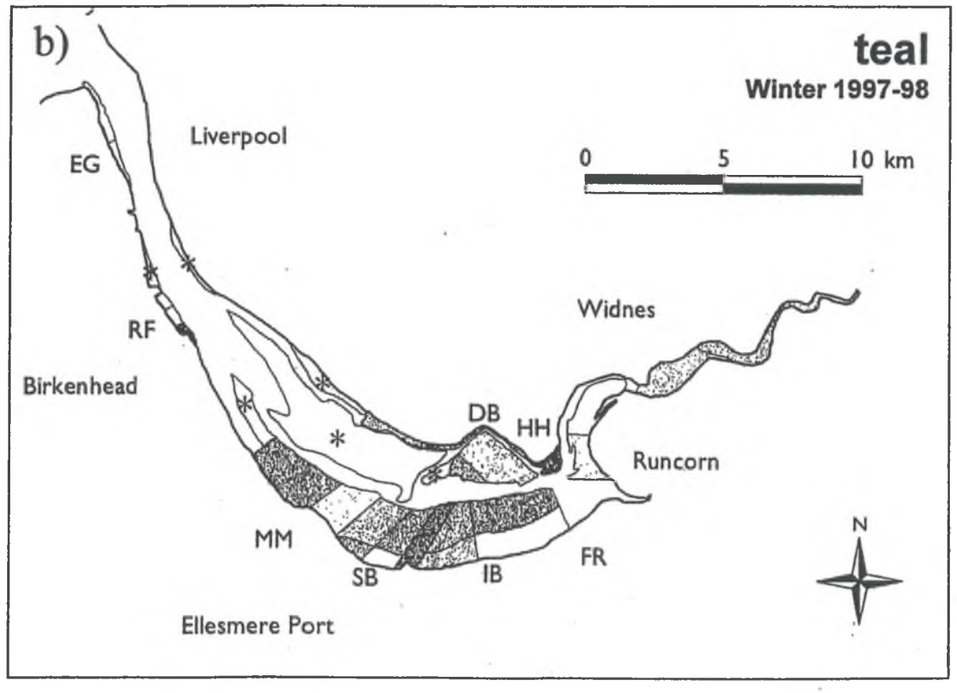

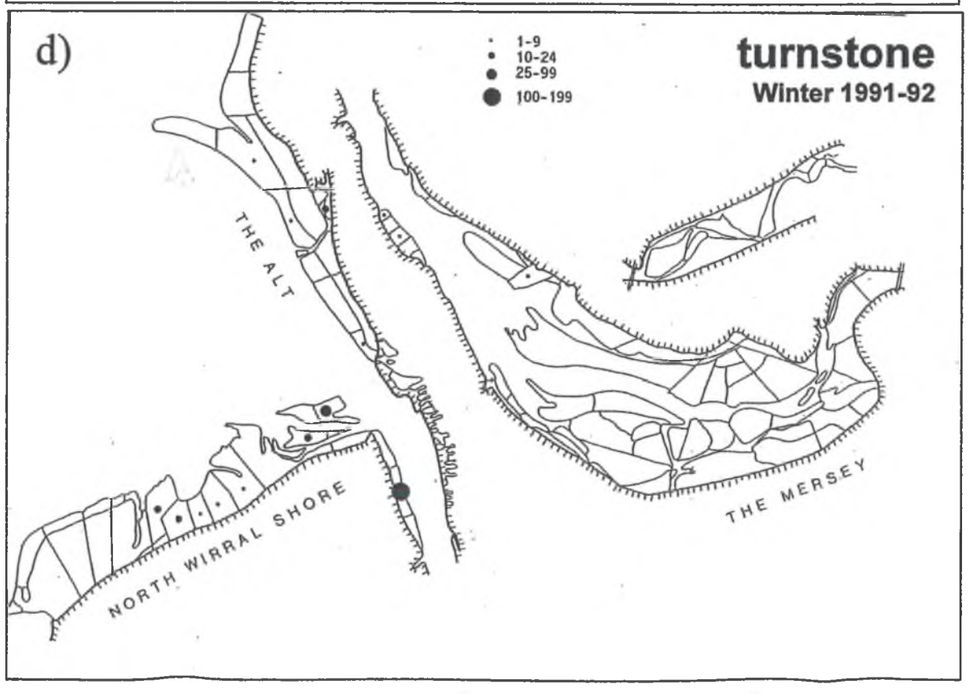

Figure 5

Project Title: Mersey Estuary Baseline Biological Survey.

Title: Low water distribution of key dunlin, teal, ringed plover and turnstone at low water in the Mersey.

Project No.: A3602

Notes

a & b) reproduced from Pollit et al., 2000. (WeBS low tide counts)

c & d) reproduced from Holloway et al., 1992

Key:

EG = Egremont
RF = Rock Ferry
LA = Liverpool Airport
MM = Mount Mainsty
SB = Stanlow Banks
IB = Ince banks
FR = Frodsham
HH = Hill Head
DB = Dungeon banks
* = not counted

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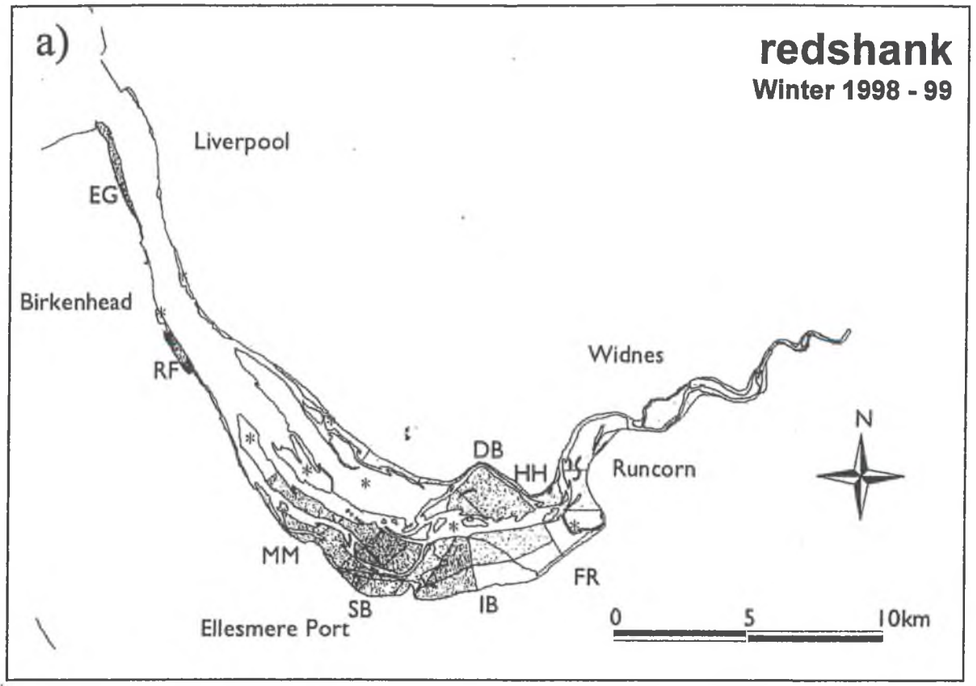

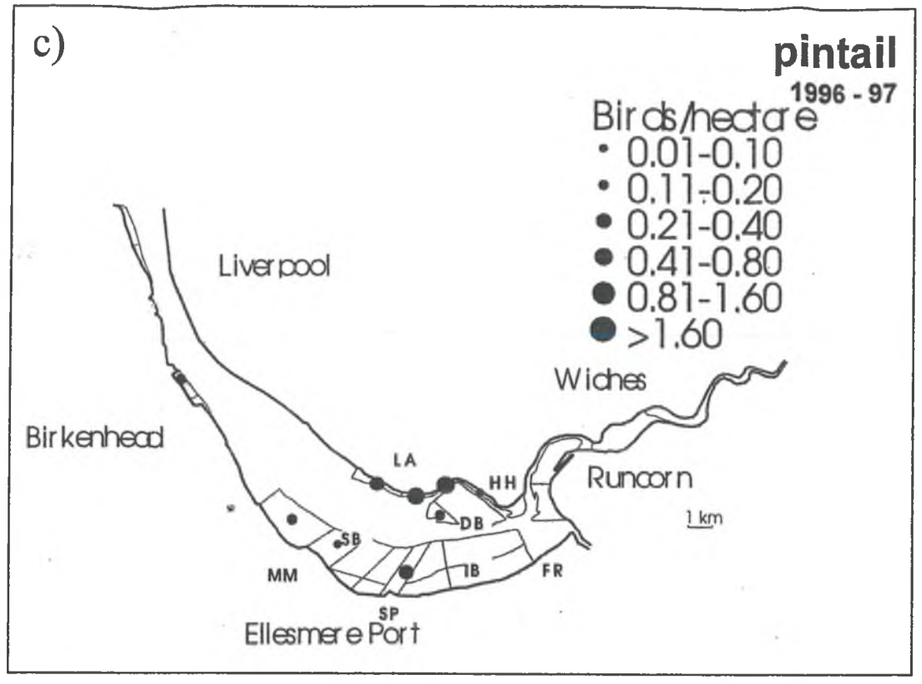

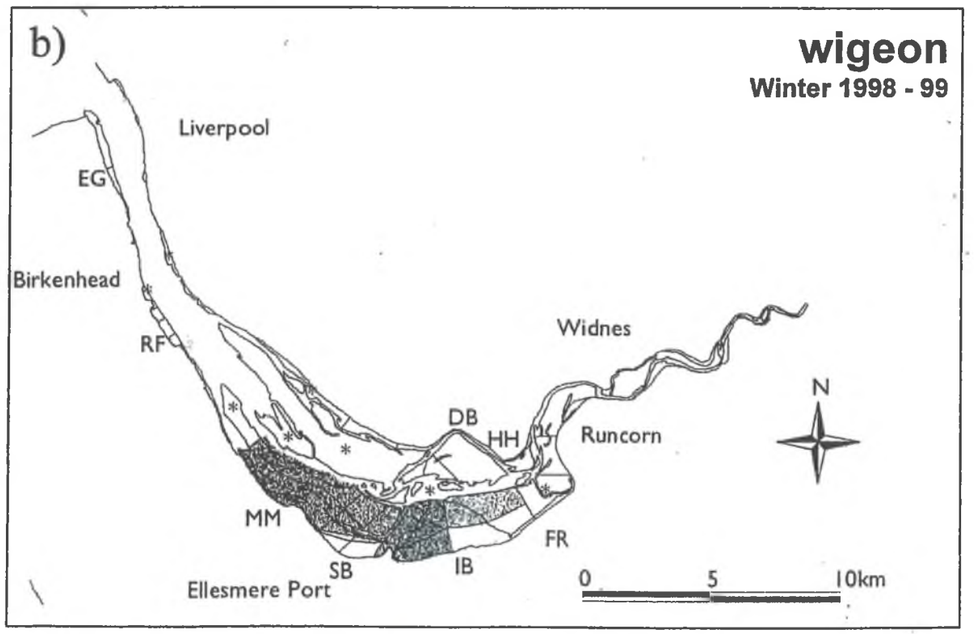

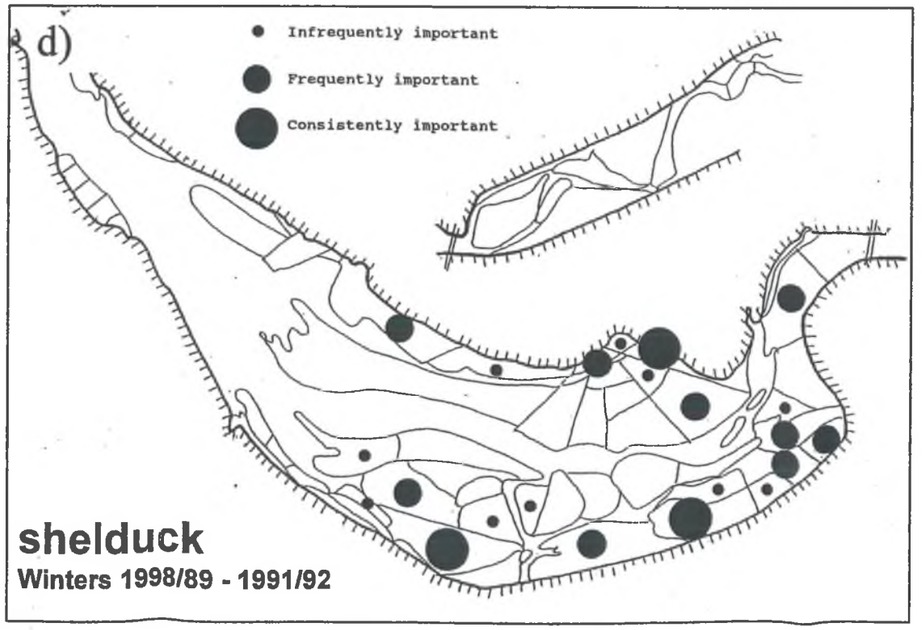

Figure 6

Project Title: Mersey Estuary Baseline Biological Survey.

Title: Low water distribution of key redshank, wigeon, pintail and shelduck at low water in the Mersey.

Project No.: A3602

Notes

a & b) reproduced from Pollit et al., 2000. (WeBS low tide counts)

c & d) reproduced from Holloway et al., 1992

Key:

EG = Egremont
RF = Rock Ferry
LA = Liverpool Airport
MM = Mount Mainsty
SB = Stanlow Banks
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FR = Frodsham
HH = Hill Head
DB = Dungeon banks
* = not counted

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Figure 7

Project Title: Mersey Estuary Baseline Biological Survey.

Title: Approximate distribution of intertidal areas sampled for the 1990/91 and 1991/92 BTO surveys

Project: A3602

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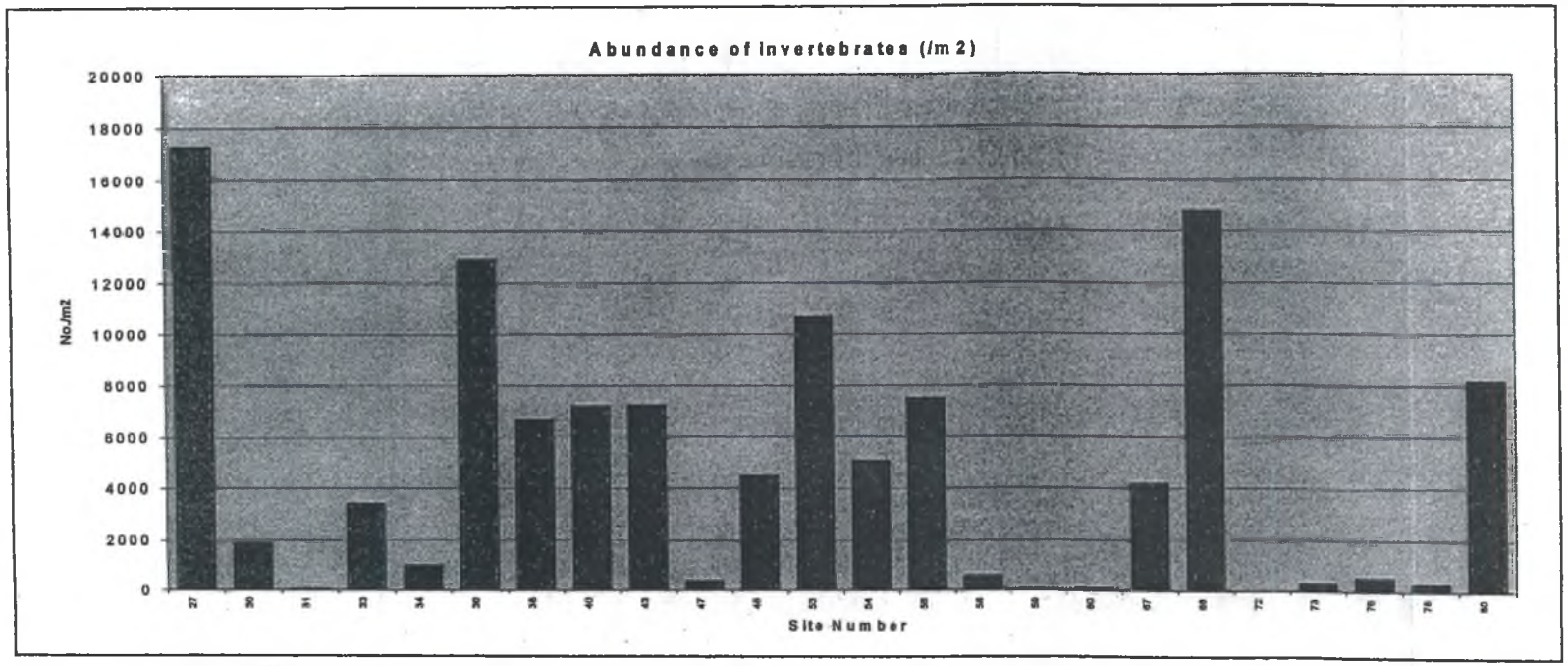

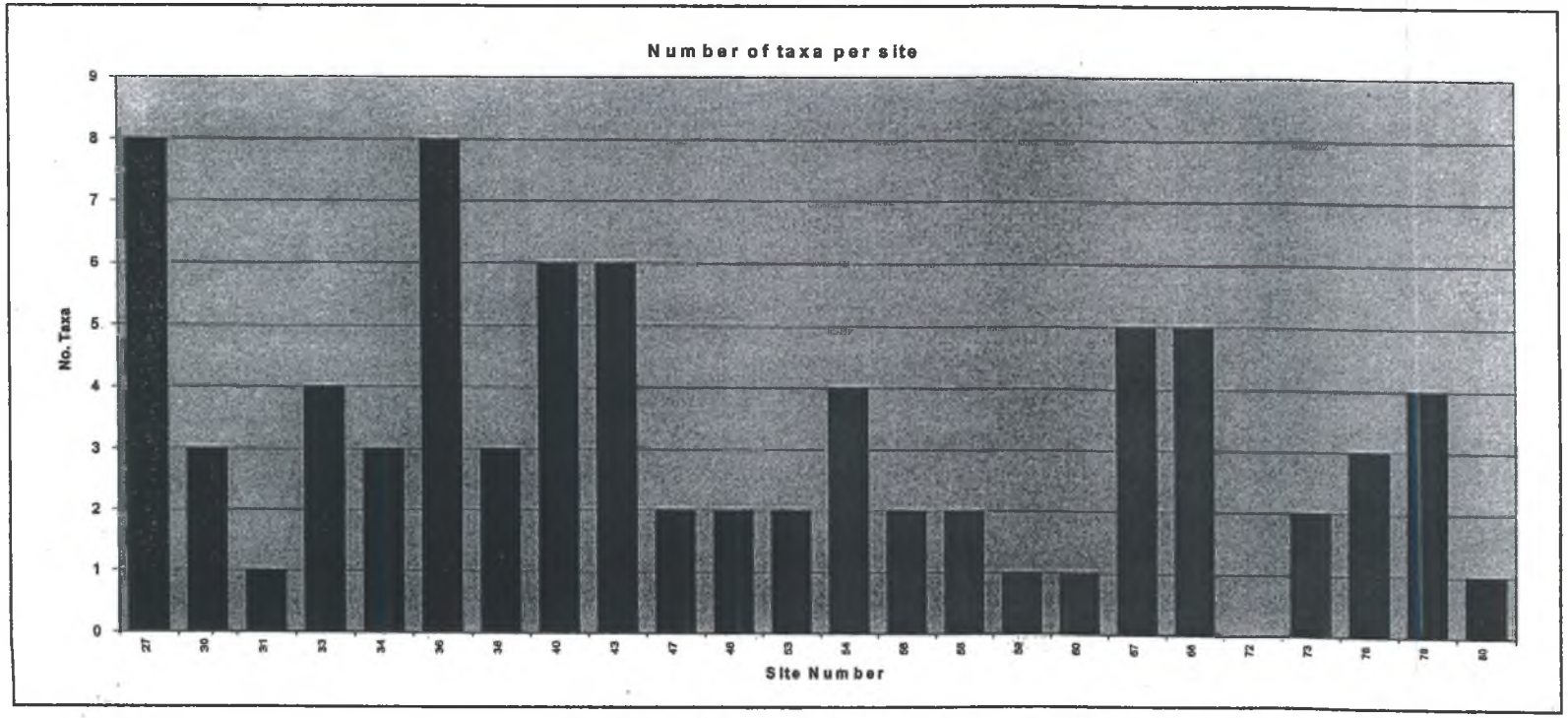

Figure 8

Project Title: Mersey Estuary Baseline Biological Survey.
Title: Abundance of invertebrates and number of taxa in each BTO survey area (1990/91)

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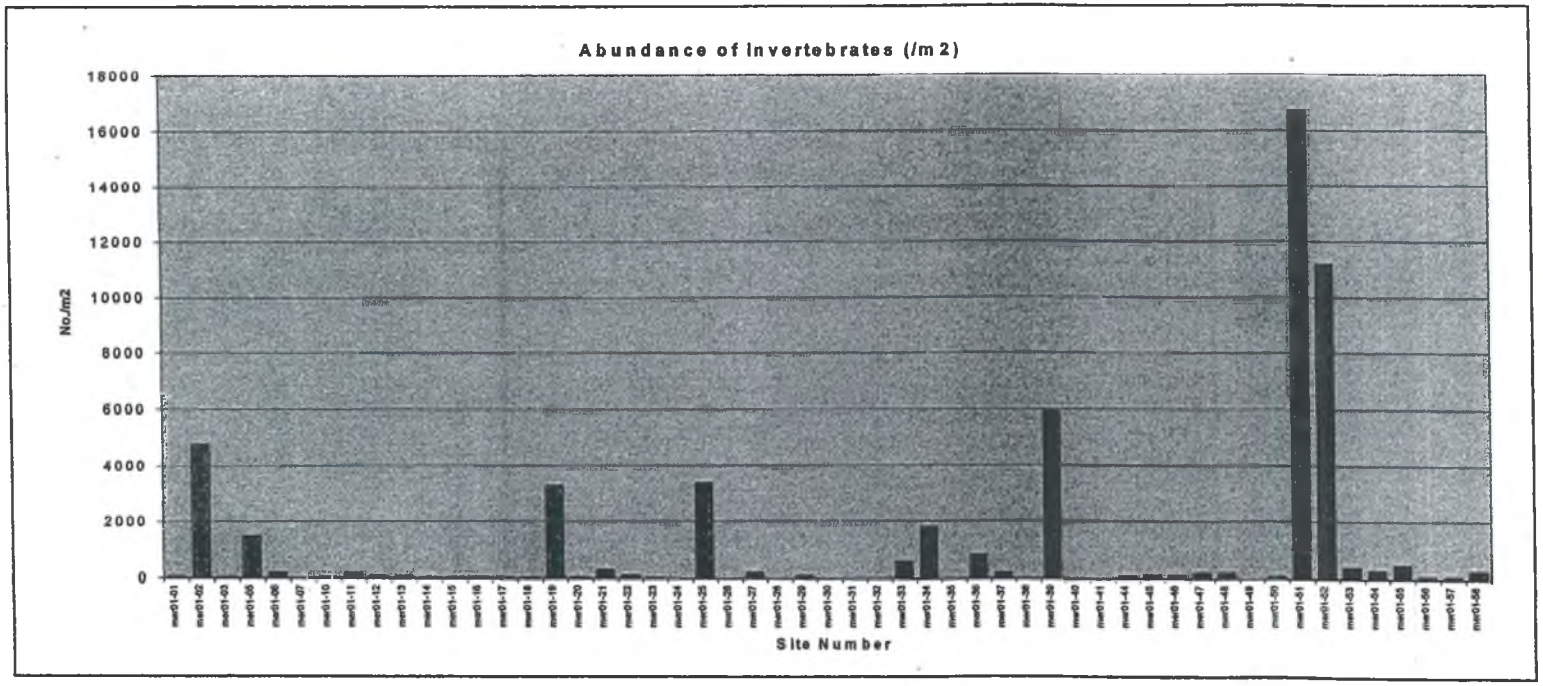

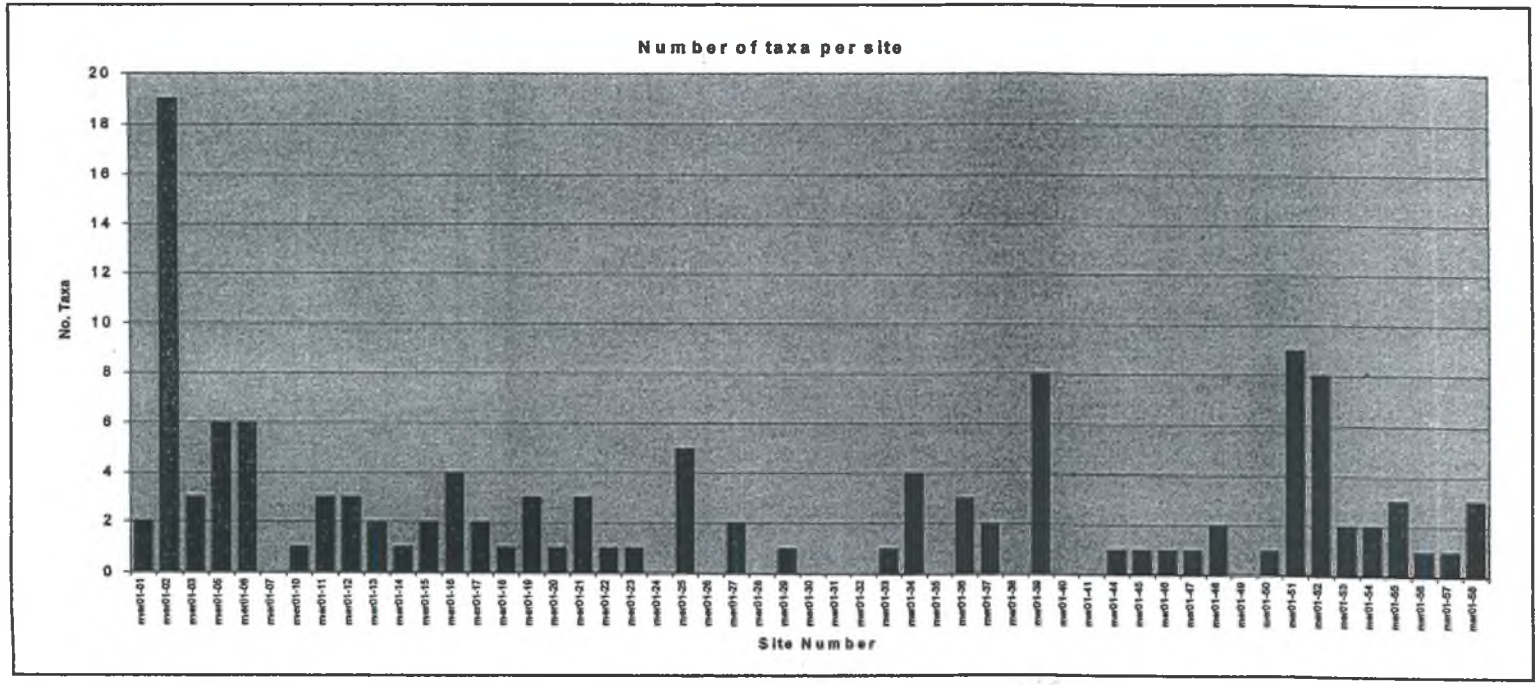

Figure 9

Project Title: Mersey Estuary Baseline Biological Survey.
Title: Abundance of invertebrates and number of taxa at each EA survey site (Aug/Sept 2001).

Project: A3602

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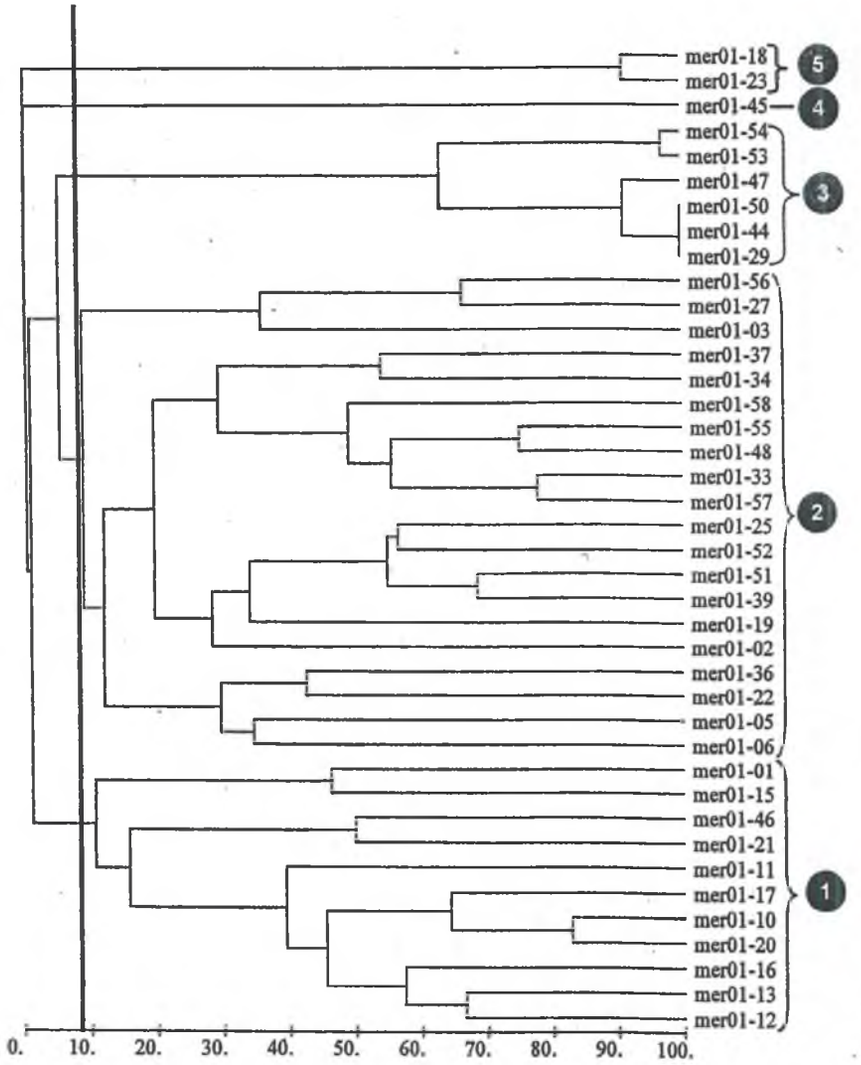

Figure 10

Project Title: Mersey Estuary Baseline Biological Survey.

Title: Dendrogram Classification plot of Environment Agency benthic survey data.

Project: A3602

Key:

1. Group 1
2. Group 2
3. Group 3
4. Group 4
5. Group 5

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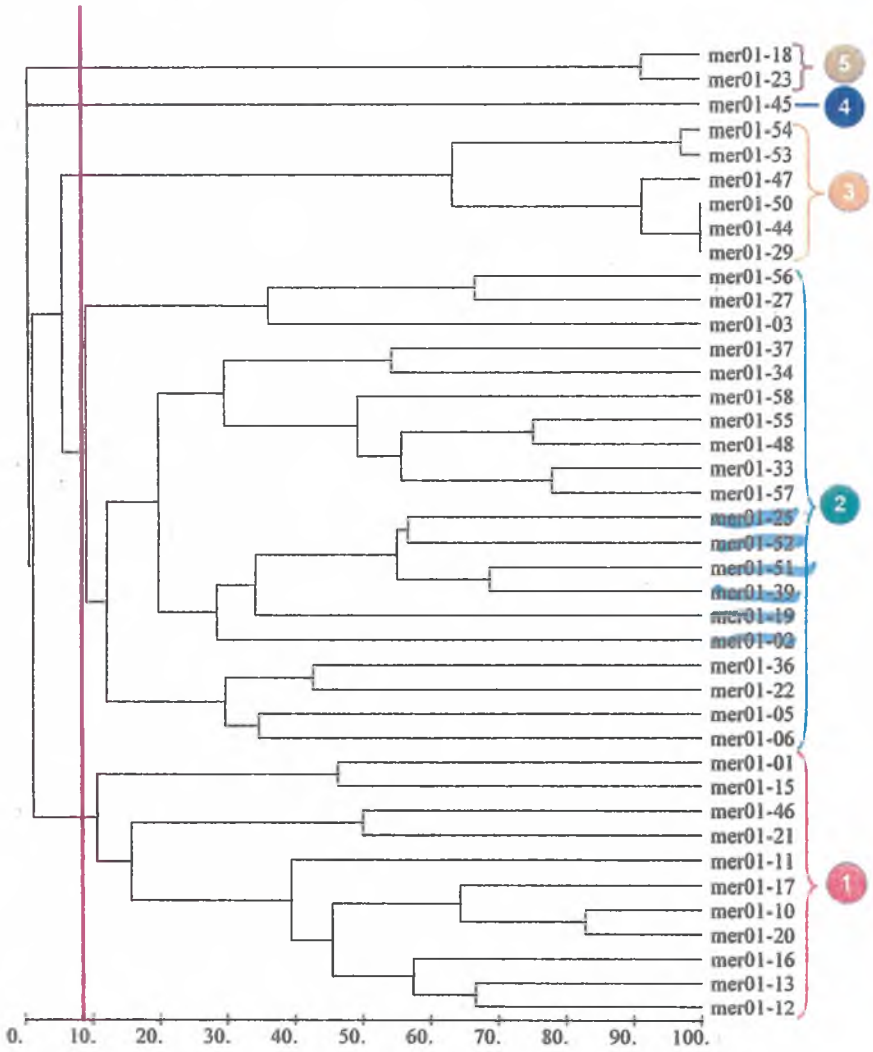

Figure 10

Project Title: Mersey Estuary Baseline Biological Survey.

Title: Dendrogram Classification plot of Environment Agency benthic survey data.

Project: A3602

Key:

- Group 1
- Group 2
- Group 3
- Group 4
- Group 5

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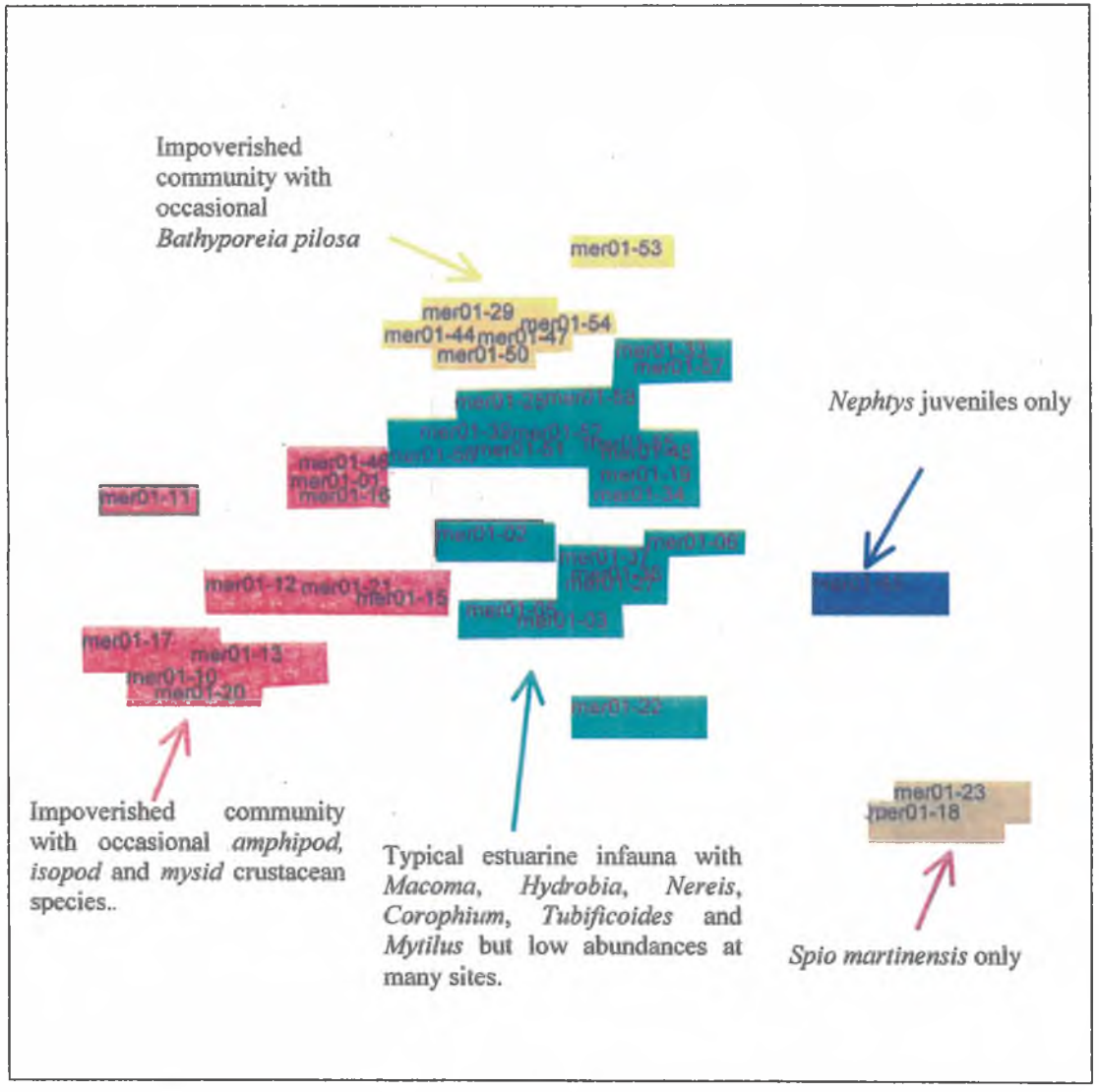
Figure 11



Project Title: Mersey Estuary Baseline Biological Survey.
Title: MDS Ordination plot of Environment Agency benthic survey data.

Project: A3602

Key:

- Group 1
- Group 2
- Group 3
- Group 4
- Group 5

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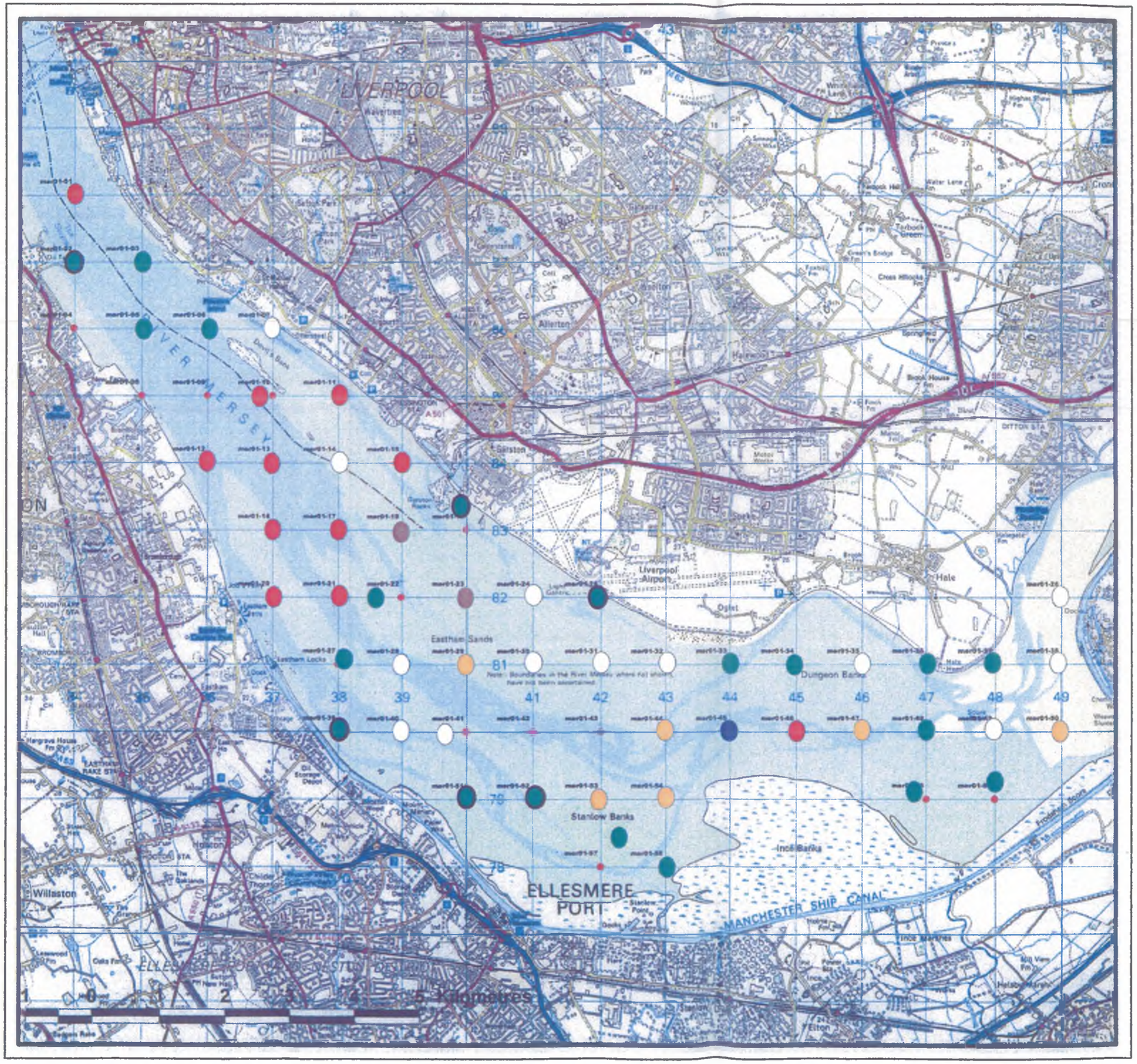

Figure 12

Project Title: Mersey Estuary Baseline Biological Survey.

Title: Spatial relationship between community groups identified from multivariate analysis of Environment Agency benthic survey data

Project No.: A3602

Key:

- Sites in Group 1
- Sites in Group 2
- Sites in Group 3
- Sites in Group 4
- Sites in Group 5
- Sites with no fauna
- Sites within Group 2 with a balanced community structure and relatively high abundance of infauna.

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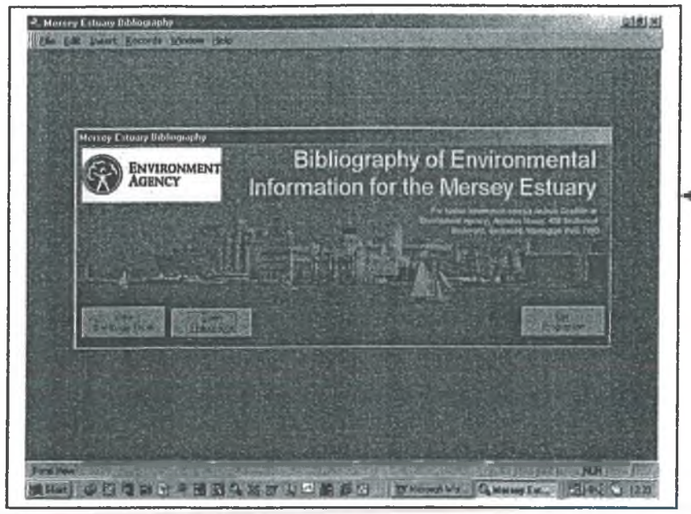
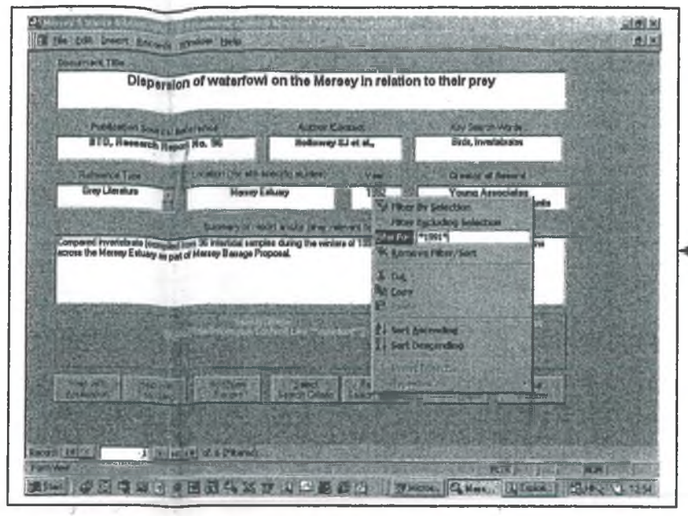


Opening access screen.

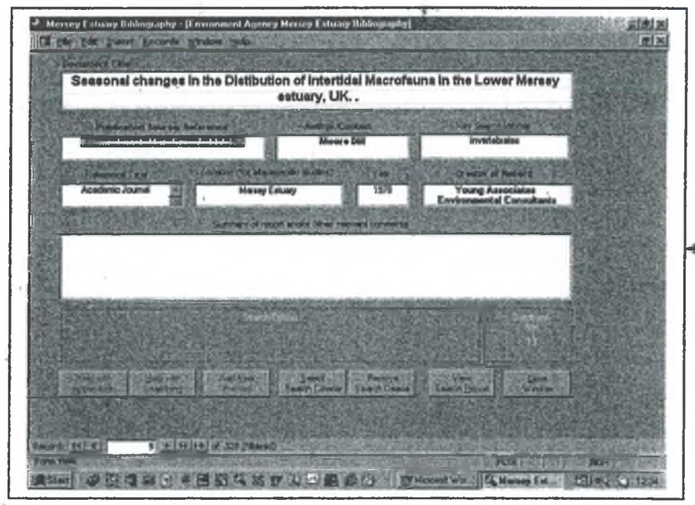
General users can access the bibliography ('Open Bibliography' button).

The database manager can also access and edit, the database tables ('View Database Table' button).



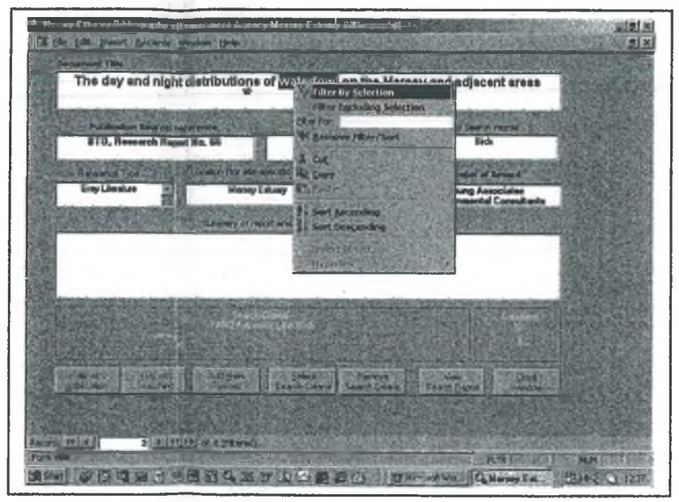
Search for any variable

An alternative approach for searching the database is to right click within the relevant field and type the criteria in the 'filter for' box. Criteria must begin and end with an asterisk and can be partial (e.g. entering *197* within the year field will show all information from the 1970's).



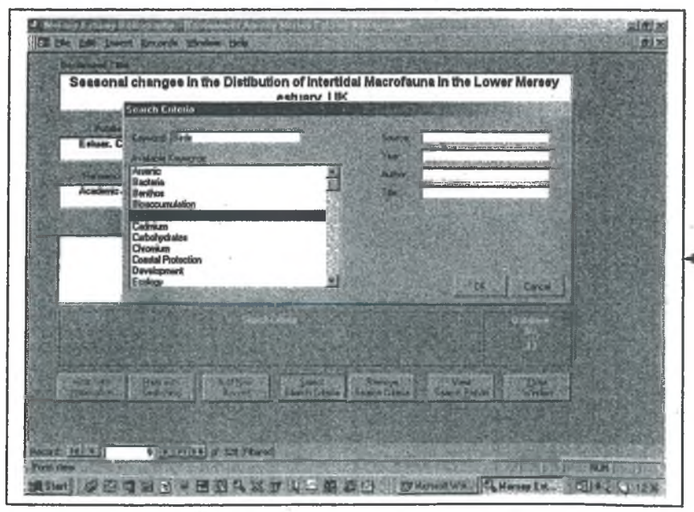
Bibliography screen

All users can interrogate database and obtain search reports via this screen



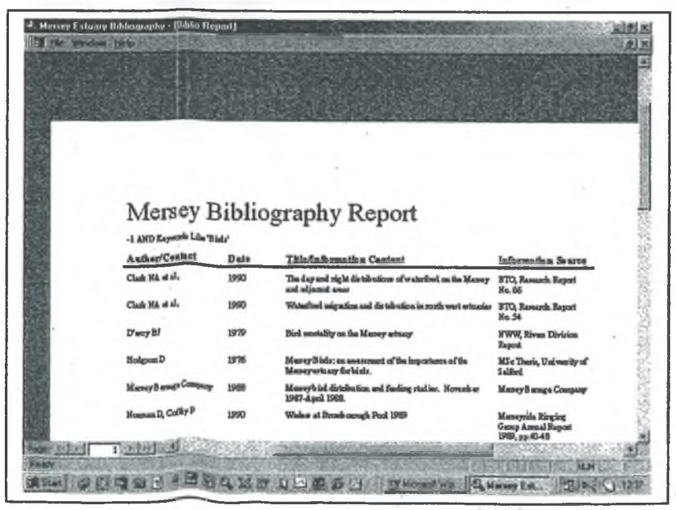
Search by selection

It is also possible to search for a word, number or phrase that is aready visible on the screen by: highlighting it, right clicking and selecting 'filter for selection'



Search criteria screen

One way to search the database is to click the 'Select Search Criteria' button and then enter the relevant search criteria within the relevant field (e.g. year, author) and/or select a relevant keyword.



Print Search Report

The results of a search can be viewed in a 'report' format by clicking the 'View Search Report' button.

Figure 13

Project Title: Mersey Estuary Baseline Biological Survey.

Title: Guide to using and interrogating the Mersey estuary database.

Project No.: A3602

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APPENDICES

Appendix 1: Contact details and responses for consultation process

Contact Association	Contact Name	Address	Tel. Number Fax Number	e-mail / website address	Correspondence
English Nature (EN)	Liam Fisher	Pier House, Wallgate, Wigan, Lancs, WN3 4AL	Tel- 01942 614017	liam.fisher@english-nature.org.uk	
British Trust for Ornithology (BTO)	Andy Musgrove	The Nunnery, Thetford, Norfolk, IP24 2PU	Tel- 01842 750050 Fax- 01842 750030		Sent list of all BTO reports on the Mersey.
Royal Society for the Protection of Birds (RSPB)	Tim Melling	Westleigh Mews, Wakefield Rd., Denby Dale, Huddersfield, HD8 8QD	Tel- 01484 861148		
The Wetland Bird Survey (WeBS)	Andy Musgrove	The Nunnery, Thetford, Norfolk, IP24 2PU	Tel- 01842 750050 Fax- 01842 750030	andy.musgrove@bto.org	Sending list of low-tide counts 96-97, 97-98, 98-99, 99-00.
Wildfowl and Wetlands Trust (WWT)	Colette Hall	Slimbridge, Gloucestershire, GL2 7BT	Tel- 01453 891926 Fax-01453 891901		Will send WeBS counts. Holds other WWT surveys, Shelduck, Whooper and Bewick's swans census. ➔ needs to know area covered.
The Wildlife Trust	Steve White (Waders Study Group)	Seaforth Nature Reserve, Port of Liverpool, L21 1JD	Tel- 01772 324129 Fax- 01772 628849	lancswt@cix.co.uk www.wildlifetrust.org.uk/lancashire	Hold no data on SPA but hold data for the Mersey narrows – contact if wanted.
Joint Nature Conservation Committee (JNCC)	Mark Tasker	Halton, Wirral, Cheshire	Tel- 01244 655701	www.jncc.gov.uk	
Department for Environment, Food and Rural Affairs (DEFRA)				wq.enquiries@defra.gsi.gov.uk	

Mersey Strategy	Caroline Salthouse			merseystrategy@zoom.co.uk	Sent list of possible contacts. Sent excel documents inc. knowledge database already compiled.
Biodiversity Record Centre	Steve McWill		Tel- 01244 383749	info@Record-lrc.co.uk	Sent species list and map of SPA/Ramsar boundary.
Department of Transport, Local government and the regions (DTLR)		North Annex, Town Hall, Brighton St., Wallasey, CH44 8ED			
Cheshire County Council	Steve Clarke	Env. Dept, Room 269, County Hall, Chester, CH1 1SF	Tel- 01244 603349 Fax- 01244 602454		Enclosed summary of the datasets used for Life Econet project. → see www.lifeeconet.com
North West Water		United Utilities, PO Box 453, Warrington, WA55 1SE			
Metropolitan Borough of Wirral	Dr I. Wallace	Town Hall, Brighton St., Wallasey, Wirral, CH44 8ED	Tel- 0151 207 0001		Hosted a research project on the New Brighton/Egremont Turnstone – funded by WMBC. Referred to university PhD theses.
Warrington Borough Council	David Bell	Palmyra House, Palmyra Square North, Warrington, WA1 1JN	Tel- 01925 444400	Dbell@warrington.gov.uk	Has details on upper Mersey SINC design (map and citation) → will send on request. Woolston Eyes SSSI, contact Brian Martin on 01925-264251 for bird records.
Liverpool Museum		William Brown St., Liverpool, L3 8EN	Tel- 0151 4784399	liverpoolmuseum@nmgm.org	Hold some info as EA. Contact Wirral Borough Council Eng. Dept.
Cheshire Wildlife Trust	Jackie Hulse and Gail Butten	Grebe House, Reaseheath, Nantwich, Cheshire, CW5 6DG	Tel- 01270 610180	jhulse@cheshirewt.cix.co.uk	Recommended contacting rECOrd, CWT do have data but rECOrd hold this and more.
Irish Sea Forum	D. F. Shaw	Oceanography Laboratories, University of Liverpool, Liverpool, L69 3BX	Tel- 0151 7944089 Fax- 0151 7944099	D.F.Shaw@liverpool.ac.uk	ISF has reports on wide variety of coastal issues. Most useful will be original reports of Irish Sea Study Group

Environment North West (ENWWEB)	Erik Bichard (Chief Exec)	Sustainability NW, Giants Basin, Potato Wharf, Castlefield, Manchester, M3 4NB	Tel- 0161 8348834 Fax- 0161 8191102	snw@snw.org.uk www.snw.org.uk	Unable to help, suggested contacting Mersey Basin Campaign.
North Western and North Wales Sea Fisheries Committee (NWNWSFC)	Dr. J Andrews	Lancaster University, Lancaster, LANCS, LA1 4YY	Tel- 01524 68745 Fax- 01524 844980	j.andrews@lancaster.ac.uk	
Mersey Basin Campaign		28th Floor, Sunley Tower, Piccadilly Plaza, Manchester, M1 4BT	Tel- 0161 2428200 Fax- 0161 2428201	campaign@merseybasin.org.uk	
Centre for Environment, Fisheries and Aquaculture Science (CEFAS)	Bernadette Eldridge	Remembrance Avenue, Burnam-On-Crouch, Essex, CMO 8HA	Tel- 01621 787225 Fax- 01621 874989	b.e.eldridge@cefas.co.uk	Passing letter to relevant colleague.
Environmental Advisory Services	Debby Allen	Bryant House, Liverpool Rd North, Maghull, Liverpool L31 2PA	Tel- 0151 9344954	eas@sefton.u-net.com	Sent list of publications they hold – call 0151 934 4951
Sefton Council	Dave McAleavy (Head of coast and countryside)	Leisure Services Department, Pavillion Buildings, 99-105 Lord St, Southport, PR8 1RJ	Tel- 01704 570173	Rangers@sccms.u-net.com	
Mersey Valley Partnership	David Potts (info. officer)	The Coach House, Norton Priary, Tudor Rd, Manor Park, Runcorn WA7 1SX	Tel- 01928 573346 Fax- 01928 581661		Recently surveyed Fiddlers Ferry power station, contact: American electric power, FFPS, Widnes Road, Cuerdley, Warrington, Cheshire, WA5 2UT.

Shoreline Management Partnership	Dr P. Barber	Shoreline Management Partnership Talwryn Green Rossett Nr Chester Flintshire LL12 0AN	Tel- 01978 760177 Fax- 01978 761065		Identified a number of potential s sources of information including Wirral Metropolitan Borough Council who hold the Shoreline Management Plan, Manchester Ship Canal Co. Acting Conservators Annual Report.
	Professor David Norman	Rosewood Cottage, Riding Lane Sutton Weaver, Runcorn, Cheshire, WA7 6PF	Tel- 01928 711064	david.norman@ physics.org	Recommended publication: "The Mersey Estuary – Naturally Ours" 1995 MS Curtis, D Norman, I Wallace. ISBN 095273300
Maritime and Coastguard Agency	Donald McDonald (District controller)	Hall Rd. West, Crosby, Liverpool, L23 8SY	Tel- 0151 9316601		Referred to an EN document issued 25 May 2001 (conservation objectives doc) contact: Mr Will Williams, Team Manager, NW Team, Pier House, Wallgate, Wigan, Lancashire, WN 3 4AL.
Irish Sea Forum	Dr Duncan Shaw	c/o 11 Baskervyle close, Heswall, Wirral, CH60 8QL		D.F.Shaw@liv.ac.uk	Summary of ISF seminar reports on www.liv.ac.uk/~isf1/isfhome.html. Contact R. T. Leah (done)
Merseyside Naturalists soc.	E Hardy	47 Woodsorrel Road, Liverpool, L15 6UB			
Proudman Oceanographic laboratory	David Prandle	Bidston Observatory, Bidston Hill, Prenton, Wirral, CH43 7RA	Tel- 0151 6538633	dp@pol.ac.uk	Referred to Associated British Ports (ABP) Southampton. →collated estuarine data (Emphasys) contact IHT @ research.abports.co.uk
Wirral Wildlife	Dr. Hilary Ash	R Dearnford Avenue, Bromborough, Wirral, CH62 6DX			
Liverpool City Council	Kevin Curran (Conservation Officer)	2nd Floor, Millennium House, Victoria St, Liverpool, L1 6JD	Tel- 0151 2335608	Kevin.Curran@liverpool.gov.uk	All records at Liverpool City Council copied from/supplied by EN

Mersey Estuary Conservation Group	Len Johnson	7 Hazlehurst Road, Frodsham, WA6 6EX			Phoned 13.02.02 (see tel. log). Sending MECG book "The Mersey Estuary – Naturally Ours".
Halton Borough Council	Paul Oldfield (Cons. Officer) Nigel Hayes (Area Manager, Widnes)	Parks + Countryside Service, Town Hall, Heath Rd, Runcorn, Cheshire, WA7 5TD	Tel- 0151 4242061	Paul.Oldfield@halton-borough.gov.uk	All Halton biological records held by rECOrd. →2nd bridge proposed therefore no. of consultants carrying out bird and aquatic surveys. *See corres in for details*
Liverpool Hope University	Paul Rooney	Environmental and Biological Studies, Hope Park, Liverpool, L16 9JD			
Hull University	Dr M. Elliott	Department of Biological Sciences University of Hull HULL HU6 7RX			
United Utilities	Dr. Peter Head	PO Box 14, 410 Birchwood Boulevard, Birchwood, Warrington			
CMACS	Dr. Rick Leah	University of Liverpool, VSEL Buildings, Campbeltown Rd, Birkenhead, CH41 9HP	Tel- 0151 650 2275	rickl@liv.ac.uk	
Prof. Tony Bradshaw		58 Knowsley Road, Liverpool, L19 OPG			
Liverpool Bay Coastal Group	Tony Smith (Secretary) Mr D. Collyer	9 Walker Close, Formby, Merseyside, L37 4DH	Tel- 01704 872374	Dave.collver@flintshire.gov.uk	Referred to Shoreline Management plan and Dr Philip Barber of Shoreline Management Partnership

Univ. of Liverpool (env. Research + consultancy)	Dr. Sheila Ross (Snr env. Consultant)	Vanguard Way, Birkenhead, Wirral, CH41 9HX	Tel- 0151 6502275	smross@liv.ac.uk	
rECOrd	Simon Wood	Chester Zoological Gardens, Upton, Chester	Tel- 01244 383749	Info@record-lrc.co.uk www.record-lrc.co.uk	Sent map of SPA/Ramsar boundary. Sent species list.
Casella	Paul Robinson	Casella			List of Casella and SGS reports. Reference list.
Mersey Estuary Counters	Graham Thomason	110 Coroners Lane, Widnes, WA8 9H7	Tel- 0151 4247257		
Wirral Borough Council (Eng. Dept.)		Town Hall, Bebington, Wirral, Merseyside, L63 7PT			
Mersey Estuary Conservation Group (MECG)	Mrs. M Baker-Schommer	56 Gussits Road, Meols, Wirral, Merseyside, CH47 7AD		Mabaker-Schommer@merseymail.com	Revising "Mersey Estuary – Naturally Ours" (MECG). Will be in touch after meeting 14.03.02 with regards to new edition.
Sustainability North West	Ceri Chamberlain	Sustainability NW, Giants Basin, Potato Wharf, Castlefield, Manchester, M3 4NB	Tel- 0161 834 8834 Fax- 0161 819 1102	www.snw.org.uk	No information held. Referred to Mersey Basin Campaign, 28th floor, Sunley Tower, Piccadilly Plaza, Manchester, M1 4BT. Tel- 0161 242 8200
ABP Garston	Callum Couper (Port Manger)	ABP Garston, Port Office, Garston, Liverpool, L19 2JW	Tel- 0151 4275971	Ccouper@abports.co.uk	

Liverpool Airport	Andrew Dutton (Env. Manager)	Liverpool Airport PLC, South Teriminal, Liverpool John Lennon Airport, Liverpool, L24 1YD	Tel- 0151 2884000 Fax- 0151 2884004	Adutton@liverpool airport.com	
Mersey Docks and Harbour Company		Mersey Docks and Harbour Company, Maritime Centre, Port of Liverpool, L21 1LA	Tel- 0151 9496000 Fax- 0151 9496300	www.merseydocks. co.uk	
Fiddlers Ferry Power Station					Telephoned, will send list of information and own bird data held.
Manchester Ship Canal Company	R. Howells (Chief Engineer)	Manchester Ship Canal Company Ltd, General Enquiries, Port Division Offices, Runcorn	Tel- 01928 567465 Fax- 01928 567469	Mail@shipcanal.co. uk	Info requested not held by the company, suggested contacting bird watchers, EN and EA.
Ellesmere Port and Neston Borough Council		Council Offices, 4 Civic way, Ellesmere Port, Cheshire, CH65 0BE	Tel- 0151 356 6566 or 0151 356 6667		

Sample Number	Site Number	Site NGR	Sample NGR	Sample Date	Sample Method	Substrate	Type	Depth(m)	X-Coord	Y-Coord
AG036	mer01-19	SJ 40000 83000	SJ 39925 83382	14-Aug-01	Hovercraft	Mud	Intertidal	n/a	339925	383382
AG037	mer01-24	SJ 41000 82000	SJ 41000 82000	14-Aug-01	Hovercraft	Sand	Intertidal	n/a	341000	382000
AG038	mer01-01	SJ 34000 88000	SJ 33998 88008	12-Sep-01	CSV	Sand	Subtidal	12.1	333998	388008
AG039	mer01-02	SJ 34000 87000	SJ 34003 86995	12-Sep-01	CSV	Mussel Shells	Subtidal	17.9	334003	386995
AG040	mer01-03	SJ 35000 87000	SJ 35008 87001	12-Sep-01	CSV	Sand	Subtidal	6.8	335008	387001
AG041	mer01-05	SJ 35000 86000	SJ 35013 86002	12-Sep-01	CSV	Shells/Stones	Subtidal	15.2	335013	386002
AG042	mer01-06	SJ 36000 86000	SJ 36001 86084	12-Sep-01	CSV	Muddy Sand	Subtidal	5.1	336001	386084
AG043	mer01-07	SJ 37000 86000	SJ 36989 85996	12-Sep-01	CSV	Sand	Subtidal	11.1	336989	385996
AG044	mer01-10	SJ 37000 85000	SJ 36794 85004	12-Sep-01	CSV	Sand	Subtidal	5.4	336794	385004
AG045	mer01-11	SJ 38000 85000	SJ 38001 84987	12-Sep-01	CSV	Sand	Subtidal	5.7	338001	384987
AG046	mer01-13	SJ 37000 84000	SJ 37008 84007	12-Sep-01	CSV	Sand	Subtidal	5.5	337008	384007
AG047	mer01-14	SJ 38000 84000	SJ 38009 83987	12-Sep-01	CSV	Sand	Subtidal	3.4	338009	383987
AG048	mer01-15	SJ 39000 84000	SJ 39005 83988	12-Sep-01	CSV	Sand	Subtidal	7.2	339005	383988
AG049	mer01-18	SJ 39000 83000	SJ 39003 82962	12-Sep-01	CSV	Sand	Subtidal	5.2	339003	382962
AG050	mer01-23	SJ 40000 82000	SJ 40010 82007	12-Sep-01	CSV	Sand	Subtidal	4.6	340010	382007
AG051	mer01-17	SJ 38000 83000	SJ 38003 82980	12-Sep-01	CSV	Sand	Subtidal	4	338003	382980
AG052	mer01-20	SJ 37000 82000	SJ 37007 81995	12-Sep-01	CSV	Sand	Subtidal	0	337007	381995
AG053	mer01-16	SJ 37000 83000	SJ 37016 82998	12-Sep-01	CSV	Sand	Subtidal	3.9	337016	382998
AG054	mer01-12	SJ 36000 84000	SJ 36008 83987	12-Sep-01	CSV	Sand	Subtidal	6.6	336008	383987

4. Conservation objectives for SPA interest features

Under Regulation 33(2)(a) of the Conservation (Natural Habitats &c.) Regulations 1994, as amended, English Nature has a duty to advise other relevant authorities as to the conservation objectives for the European site. The conservation objectives for the Mersey Estuary European marine site interest features are provided below and should be read in the context of other advice given in this package, particularly:

- the attached maps showing the extent of the sub-features;
- summary information on the interest of each of the features; and
- the favourable condition table, providing information on how to recognise favourable condition for the feature, which will act as a basis for the development of a monitoring programme

4.1 The conservation objective for the internationally important populations of regularly occurring migratory bird species

Subject to natural change, maintain in favourable condition[5] the habitats for the **internationally important populations of regularly occurring migratory bird species**, under the Birds Directive, in particular:

- **Intertidal sediments**
- **Rocky shores**
- **Saltmarsh**

Numbers of bird species using these habitats are given in Table 1

4.2 The conservation objective for the internationally important assemblage of waterfowl

Subject to natural change, maintain in favourable condition[5] the habitats for the **internationally important assemblage of waterfowl,** under the Birds Directive, in particular:

- **Intertidal sediments**
- **Rocky shores**
- **Saltmarsh**

Numbers of bird species using these habitats are given in Table 1

Note: These SPA conservation objectives focus on habitat condition in recognition that bird populations may change as a reflection of national or international trends or events. Annual counts for qualifying species will be used by English Nature, in the context of five year peak means, together with available information on UK population and distribution trends, to assess whether this SPA is continuing to make an appropriate contribution to the Favourable Conservation Status of the species across Europe.

[5] For a detailed definition of how to recognise favourable condition see table 2 (Section 5)

Table 1 Information on populations of bird species qualifying under the Birds Directive using the Mersey Estuary European marine site at the time the SPA was classified (1995).

Internationally important populations of regularly occurring migratory bird species.[6]

Species	Population (5 yr peak mean for 1987/88 - 1991/92 (unless stated otherwise)*	
Dunlin (*Calidris alpina*) - wintering	2.3% east Atlantic flyway	32,528 birds
Redshank (*Tringa totanus*) - wintering	2.7% east Atlantic flyway	4,080 birds
Pintail (*Anas acuta*) - wintering	8.5% north-west European	5,925 birds
Ringed plover (*Charadrius hiaticula*) - autumn passage	2.9% east Atlantic flyway	(1989) 1,453 birds
Shelduck (*Tadorna tadorna*) - wintering	1.8% north-west European	4,510 birds
Teal (*Anas crecca*) - wintering	2.9% north-west European	11,705 birds
Redshank (*Tringa totanus*) - autumn passage	2.3% east Atlantic flyway	(1987 to 1991) 3,516 birds

An internationally important assemblage of waterfowl.

Importance	Population (5 yr peak mean 1987/88 - 1991/92)*
Mersey Estuary supports large populations of wintering waterfowl.	78,015 individual birds (47,714 waders and 30,301 wildfow.

Nationally important bird populations within internationally important assemblages of water fowl

Species	Importance†	
Wigeon (*Anas penelope*)	2.6% G.B.	Nationally important population
Grey plover (*Pluvialis squatarola*)	4.1% G.B.	Nationally important population
Black-tailed godwit (*Limosa limosa*)	2.2% G.B.	Nationally important population
Curlew *(Numenius arquata)*	1.6% G.B.	Nationally important population

†Of additional non-qualifying interest

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6 The Mersey Estuary is regularly used by 1% or more of the biogeographical population of a regularly occurring species (other than those listed on Annex 1) in any season (Cranswick *et al.*, 1995).

Species	Importance
Redshank *(Tringa totanus)* - spring passage i.e. not component of wintering assemblage	Nationally important population
Dunlin *(Calidris alpina)* - autumn passage i.e. not component of wintering assemblage	Nationally important population

*** SPA citation (October 1993) held on Register of European marine sites for Great Britain.**

NB: A number of species may be added following the SPA review.

5. Favourable condition table

The favourable condition table is supplied as an integral part of English Nature's Regulation 33 advice package. It is intended to supplement the conservation objectives only in relation to management of activities and requirements on monitoring the condition of the site and its features. The table **does not by itself** provide a comprehensive basis on which to assess plans and projects as required under Regulations 20 and 48-50, but it does provide a basis to inform the scope and nature of any 'appropriate assessment' that may be needed. It should be noted that appropriate assessments are, by contrast, a separate activity to condition monitoring requiring consideration of issues specific to individual plans or projects. English Nature will provide more detailed advice to competent and relevant authorities to assess the implications of any given plan or project under the Regulations, where appropriate, at the time a plan or project is being considered.

The favourable condition table is the principle source of information that English Nature will use to assess the condition of an interest feature and as such comprises indicators of condition. On many terrestrial European sites, we know sufficient about the preferred or target condition of qualifying habitats to be able to define measures and associated targets for all attributes to be assessed in condition monitoring. Assessments as to whether individual interest features are in favourable condition will be made against these targets. In European marine sites we know less about habitat condition and find it difficult to specify favourable condition. Individual sites within a single marine habitat category are also all very different, further hampering the identification of generic indicators of condition. Accordingly, in the absence of such information, condition of interest features in European marine sites will be assessed against targets based on the existing conditions, which may need to be established through baseline surveys in many cases.

The assumption that existing interest features on European marine sites are in favourable condition will be tested in the 2000 - 2006 reporting period and the results subsequently fed back into our advice and site management. Where there is more than one year's observations on the condition of marine habitats, all available information will need to be used to set the site within long-term trends in order to form a view on favourable condition. Where it may become clear that certain attributes are a cause for concern, and if detailed studies prove this correct, restorative management actions will need to be taken to return the interest feature from unfavourable to favourable condition. It is the intention of English Nature to provide quantification of targets in the favourable condition table during the 2000 - 2006 reporting period.

This advice also provides the basis for discussions with management and advisory groups, and as such the attributes and associated measures and targets may be modified over time. The aim is to produce a single agreed set of attributes that will then be monitored in order to report on the condition of features. Monitoring of the attributes may be of fairly coarse methodology, underpinned by more rigorous methods on specific areas within the site. To meet UK agreed common standards, English Nature will be committed to reporting on each of the attributes subsequently listed in the final version of the table, although the information to be used may be collected by other organizations through agreements.

The table will be an important, but not the only, driver of the site monitoring programme. Other data, such as results from compliance monitoring and appropriate assessments, will also have an important role in assessing condition. The monitoring programme will be developed as part of the management scheme process through discussion with the relevant authorities and other interested parties. English Nature will be responsible for collating the information required to assess condition and will form a judgement on the condition of each feature within the site, taking into account all available information and using the favourable condition table as a guide.

Box 1	**Glossary of terms used in the favourable condition table**
Interest feature	The habitat or species for which the site has been selected.
Sub-feature	An ecologically important sub-division of the interest feature.
Attribute	Selected characteristic of an interest feature/sub-feature which provides an indication of the condition of the feature to which it applies.
Measure	What will be measured in terms of the units of measurement, arithmetic nature and frequency at which the measurement is taken. This measure will be attained using a range of methods from broad scale to more specific across the site.
Target	This defines the desired condition of an attribute, taking into account fluctuations due to natural change. Changes that are significantly different from the target will serve as a trigger mechanism through which some further investigation or remedial action is taken.
Comments	The rationale for selection of the attribute.

Table 2 Favourable Condition Table for Mersey Estuary European marine site

Numbers of bird species using these habitats are given in Table 1

NB - Many of the attributes will be able to be monitored at the same time or during the same survey. The frequency of sampling for many attributes may need to be greater during the first reporting cycle in order to characterise the site and establish the baseline.

INTEREST FEATURE	SUB-FEATURE	ATTRIBUTE	MEASURE	TARGET	COMMENTS
Internationally important assemblage including internationally important populations of migratory species	All Sub-features	Disturbance in feeding and roosting areas.	Reduction or displacement of wintering birds measured using 5 year peak mean information on populations.	No significant reduction in numbers or displacement of wintering birds from an established baseline, subject to natural change.	Significant disturbance attributable to human activities can result in reduced food intake and / or increased energy expenditure. Five year peak mean information on populations will be used as the basis for assessing whether disturbance is damaging.
		Absence of obstruction to view lines	Openness of terrain unrestricted by obstructions, measured periodically (frequency to	No increase in obstructions to existing bird view lines, subject to natural change.	Waterfowl require unrestricted views over 200m to allow early detection of predators when feeding and roosting.
	Intertidal sediments	Extent and distribution of habitat	Area (ha), measured once per reporting cycle.	No decrease in extent from an established baseline[7], subject to natural change.	Intertidal sediments and their communities provide both roosting and feeding areas for the migratory species of birds.
	Intertidal sediments and saltmarsh	Food availability	Presence and abundance of intertidal invertebrates. Measured periodically (frequency to be determined)	Presence and abundance of prey species should not deviate significantly from an established baseline[7], subject to natural change.	Important prey species are marine invertebrates such as molluscs, marine worms and crustaceans including: *Nereis, Macoma, Hydrobia, Crangon* and *Carcinus* for dunlin, *Hydrobia, Macoma, Corophium* and *Nereis* for redshank, *Nereis, Hydrobia* and *Corophium* for shelduck, *Hydrobia* for teal and pintail, *Macoma, Cerastoderma and Nereis* for black-tailed godwit, *Nereis, Hydrobia, Corophium* for curlew, *Nereis, Arenicola and Notomastus* for grey plover, *Gammarus* for ringed plover.

INTEREST FEATURE	SUB-FEATURE	ATTRIBUTE	MEASURE	TARGET	COMMENTS
Internationally important assemblage including internationally important populations of migratory species	Intertidal sediments	Food availability	Presence and abundance of mud-surface plants and green algae. Measured periodically (frequency to be determined)	Presence and abundance of prey species should not deviate significantly from an established baseline[7], subject to natural change.	*Enteromorpha* is important for wigeon
	Rocky shores	Extent and distribution of habitat	Area (ha), measured once per reporting cycle.	No decrease in extent from an established baseline[7], subject to natural change.	Waterfowl feed and roost on the rocky shores of the Mersey Estuary SPA.
		Food availability	Presence and abundance of intertidal invertebrates and green algae. Measured periodically (frequency to be determined)	Presence and abundance of prey species should not deviate significantly from an established baseline[7], subject to natural change.	Waterfowl including ringed plover, redshank and curlew. Prey species include marine invertebrates such as molluscs and crustaceans including: *Nereis, Macoma, Hydrobia, Crangon* and *Carcinus* for dunlin, *Hydrobia, Macoma, Corophium* and *Nereis* for redshank, *Nereis, Hydrobia* and *Corophium* for shelduck, *Hydrobia* for teal and pintail, *Macoma, Cerastoderma and Nereis* for black-tailed godwit, *Nereis, Hydrobia, Corophium* for curlew, *Nereis, Arenicola and Notomastus* for grey plover, *Gammarus* for ringed plover and *Enteromorpha* for wigeon.
	Saltmarsh	Extent and distribution of habitat	Area (ha), measured once per reporting cycle.	No decrease in extent from an established baseline[7], subject to natural change.	Waterfowl feed and roost within the saltmarsh areas of the Mersey Estuary SPA.
		Food availability	Presence and abundance of soft leaved and seed bearing plants. Measured periodically (frequency to be determined).	Presence and abundance of food species should not deviate significantly from an established baseline[7], subject to natural change.	*Salicornia* and *Atriplex* are important for teal. *Agrostis stolonifera, Puccinellia maritima* and *Salicornia spp.* important for wigeon.
		Vegetation Characteristics	Open, short vegetation or bare ground predominating (roosting and feeding).	Vegetation height throughout areas used for feeding and roosting should not deviate significantly from an established baseline[7], subject to natural change.	Vegetation of <10cm is required throughout areas used by roosting waders e.g. dunlin and redshank. Wigeon require sward heights of <5cm in areas used for feeding.

[7] Baselines to be determined during the first reporting cycle.

NB. Extreme events (such as storms reducing or increasing salinities, exceptionally cold winters or warm summers) also need to be recorded as they may be critical in influencing ecological issues in the Mersey Estuary and may well be missed by routine monitoring.

Appendix 3: Results of Environment Agency Summer 2001 Invertebrate Survey

Sample Number	Site Number	Site NGR	Sample NGR	Sample Date	Sample Method	Substrate	Type	Depth (m)	X-Coord	Y-Coord
AG001	mer01-26	SJ 49000 82000	SJ 48975 81987	13-Aug-01	Hovercraft	Sand	Intertidal	n/a	348975	381987
AG002	mer01-37	SJ 48000 81000	SJ 48002 80995	13-Aug-01	Hovercraft	Sand	Intertidal	n/a	348002	380995
AG003	mer01-38	SJ 49000 81000	SJ 48937 80936	13-Aug-01	Hovercraft	Sand	Intertidal	n/a	348937	380936
AG004	mer01-50	SJ 49000 80000	SJ 49006 79994	13-Aug-01	Hovercraft	Muddy Sand	Intertidal	n/a	349006	379994
AG005	mer01-49	SJ 48000 80000	SJ 47942 80008	13-Aug-01	Hovercraft	Sand	Intertidal	n/a	347942	380008
AG006	mer01-56	SJ 48000 79000	SJ 48005 79279	13-Aug-01	Hovercraft	Sandy Mud	Intertidal	n/a	348005	379279
AG007	mer01-55	SJ 47000 79000	SJ 46885 79130	13-Aug-01	Hovercraft	Mud	Intertidal	n/a	346885	379130
AG008	mer01-48	SJ 47000 80000	SJ 46972 79907	13-Aug-01	Hovercraft	Sand	Intertidal	n/a	346972	379907
AG009	mer01-36	SJ 47000 81000	SJ 46999 80973	13-Aug-01	Hovercraft	Mud	Intertidal	n/a	346999	380973
AG010	mer01-35	SJ 46000 81000	SJ 45995 80973	13-Aug-01	Hovercraft	Sand	Intertidal	n/a	345995	380973
AG011	mer01-47	SJ 46000 80000	SJ 45992 80033	13-Aug-01	Hovercraft	Sand	Intertidal	n/a	345992	380033
AG012	mer01-46	SJ 45000 80000	SJ 44999 79997	13-Aug-01	Hovercraft	Sand	Intertidal	n/a	344999	379997
AG013	mer01-34	SJ 45000 81000	SJ 45068 80997	13-Aug-01	Hovercraft	Sandy Mud	Intertidal	n/a	345068	380997
AG014	mer01-33	SJ 44000 81000	SJ 44008 80993	13-Aug-01	Hovercraft	Sand	Intertidal	n/a	344008	380993
AG015	mer01-45	SJ 44000 80000	SJ 44006 79992	13-Aug-01	Hovercraft	Sand	Intertidal	n/a	344006	379992
AG016	mer01-32	SJ 43000 81000	SJ 43003 81001	13-Aug-01	Hovercraft	Sand	Intertidal	n/a	343003	381001
AG017	mer01-44	SJ 43000 80000	SJ 42995 79999	13-Aug-01	Hovercraft	Sand	Intertidal	n/a	342995	379999
AG018	mer01-54	SJ 43000 79000	SJ 42997 78995	13-Aug-01	Hovercraft	Sand	Intertidal	n/a	342997	378995
AG019	mer01-58	SJ 43000 78000	SJ 43003 78038	13-Aug-01	Hovercraft	Mud	Intertidal	n/a	343003	378038
AG020	mer01-57	SJ 42000 79000	SJ 42280 78462	13-Aug-01	Hovercraft	Mud	Intertidal	n/a	342280	378462
AG021	mer01-53	SJ 42000 79000	SJ 42047 78943	13-Aug-01	Hovercraft	Sand	Intertidal	n/a	342047	378943
AG022	mer01-31	SJ 42000 81000	SJ 42001 80999	13-Aug-01	Hovercraft	Sand	Intertidal	n/a	342001	380999
AG023	mer01-25	SJ 42000 82000	SJ 41999 82019	13-Aug-01	Hovercraft	Mud	Intertidal	n/a	341999	382019
AG024	mer01-52	SJ 41000 79000	SJ 40996 78996	14-Aug-01	Hovercraft	Mud	Intertidal	n/a	340996	378996
AG025	mer01-51	SJ 40000 79000	SJ 40001 78998	14-Aug-01	Hovercraft	Mud	Intertidal	n/a	340001	378998
AG026	mer01-39	SJ 38000 81000	SJ 38003 79997	14-Aug-01	Hovercraft	Mud	Intertidal	n/a	338003	379997
AG027	mer01-40	SJ 39000 80000	SJ 39002 80005	14-Aug-01	Hovercraft	Sandy Mud	Intertidal	n/a	339002	380005
AG028	mer01-41	SJ 40000 80000	SJ 39662 79962	14-Aug-01	Hovercraft	Sand	Intertidal	n/a	339662	379962
AG029	mer01-43	SJ 42000 80000	SJ 42006 80002	14-Aug-01	Hovercraft	Sand	Intertidal	n/a	342006	380002
AG030	mer01-30	SJ 41000 81000	SJ 40955 81030	14-Aug-01	Hovercraft	Sand	Intertidal	n/a	340955	381030
AG031	mer01-29	SJ 40000 81000	SJ 40000 81000	14-Aug-01	Hovercraft	Sand	Intertidal	n/a	340000	381000
AG032	mer01-28	SJ 39000 81000	SJ 38981 81025	14-Aug-01	Hovercraft	Muddy Sand	Intertidal	n/a	338981	381025
AG033	mer01-27	SJ 38000 81000	SJ 38148 81082	14-Aug-01	Hovercraft	Muddy Sand	Intertidal	n/a	338148	381082
AG034	mer01-21	SJ 38000 82000	SJ 38004 81997	14-Aug-01	Hovercraft	Sand	Intertidal	n/a	338004	381997
AG035	mer01-22	SJ 39000 82000	SJ 38641 81960	14-Aug-01	Hovercraft	Muddy Sand	Intertidal	n/a	338641	381960

Sample Number	Site Number	Site NGR	Sample NGR	Sample Date	Sample Method	Substrate	Type	Depth (m)	X-Coord	Y-Coord
AG036	mer01-19	SJ 40000 83000	SJ 39925 83382	14-Aug-01	Hovercraft	Mud	Intertidal	n/a	339925	383382
AG037	mer01-24	SJ 41000 82000	SJ 41000 82000	14-Aug-01	Hovercraft	Sand	Intertidal	n/a	341000	382000
AG038	mer01-01	SJ 34000 88000	SJ 33998 88008	12-Sep-01	CSV	Sand	Subtidal	12.1	333998	388008
AG039	mer01-02	SJ 34000 87000	SJ 34003 86995	12-Sep-01	CSV	Mussel Shells	Subtidal	17.9	334003	386995
AG040	mer01-03	SJ 35000 87000	SJ 35008 87001	12-Sep-01	CSV	Sand	Subtidal	6.8	335008	387001
AG041	mer01-05	SJ 35000 86000	SJ 35013 86002	12-Sep-01	CSV	Shells/Stones	Subtidal	15.2	335013	386002
AG042	mer01-06	SJ 36000 86000	SJ 36001 86084	12-Sep-01	CSV	Muddy Sand	Subtidal	5.1	336001	386084
AG043	mer01-07	SJ 37000 86000	SJ 36989 85996	12-Sep-01	CSV	Sand	Subtidal	11.1	336989	385996
AG044	mer01-10	SJ 37000 85000	SJ 36794 85004	12-Sep-01	CSV	Sand	Subtidal	5.4	336794	385004
AG045	mer01-11	SJ 38000 85000	SJ 38001 84987	12-Sep-01	CSV	Sand	Subtidal	5.7	338001	384987
AG046	mer01-13	SJ 37000 84000	SJ 37008 84007	12-Sep-01	CSV	Sand	Subtidal	5.5	337008	384007
AG047	mer01-14	SJ 38000 84000	SJ 38009 83987	12-Sep-01	CSV	Sand	Subtidal	3.4	338009	383987
AG048	mer01-15	SJ 39000 84000	SJ 39005 83988	12-Sep-01	CSV	Sand	Subtidal	7.2	339005	383988
AG049	mer01-18	SJ 39000 83000	SJ 39003 82962	12-Sep-01	CSV	Sand	Subtidal	5.2	339003	382962
AG050	mer01-23	SJ 40000 82000	SJ 40010 82007	12-Sep-01	CSV	Sand	Subtidal	4.6	340010	382007
AG051	mer01-17	SJ 38000 83000	SJ 38003 82980	12-Sep-01	CSV	Sand	Subtidal	4	338003	382980
AG052	mer01-20	SJ 37000 82000	SJ 37007 81995	12-Sep-01	CSV	Sand	Subtidal	0	337007	381995
AG053	mer01-16	SJ 37000 83000	SJ 37016 82998	12-Sep-01	CSV	Sand	Subtidal	3.9	337016	382998
AG054	mer01-12	SJ 36000 84000	SJ 36008 83987	12-Sep-01	CSV	Sand	Subtidal	6.6	336008	383987

Species abundance results of Environment Agency benthic survey of the Mersey (Summer 2001)

	mer01-37	mer01-50	mer01-56	mer01-55	mer01-48	mer01-36	mer01-35	mer01-47	mer01-46	mer01-34	mer01-33	mer01-45	mer01-44	mer01-54
	Core	Core	Core	Core	Core	Core	Core	Core	Core	Core	Core	Core	Core	Core
	AG002	AG004	AG006	AG007	AG008	AG009	AG010	AG011	AG012	AG013	AG014	AG015	AG017	AG018
Nemertean spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nemertean sp. indet. A	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nematoda spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eteone longa	0	0	0	0	0	0	0	0	100	0	0	0	0	0
Anaitides mucosa	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eumida sanguinea	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Glycera tridactyla	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hediste diversicolor	100	0	0	100	100	0	0	0	0	200	0	0	0	0
Nephtys spp. (incl. juveniles)	0	0	0	0	0	0	0	0	0	0	0	100	0	0
Lumbrineris sp. indet.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polydora sp.indet.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polydora ?ciliata	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polydora ?cornuta	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pygospio elegans	100	0	0	0	0	0	0	0	0	300	0	0	0	0
Spio martinensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Streblospio shrubsolii	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cirratulidae sp. indet.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capitella sp. complex	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tubificidae spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Heterochaeta costata	0	0	0	100	0	200	0	0	0	0	0	0	0	0
Tubificoides benedii	0	0	100	0	0	0	0	0	0	0	0	0	0	0
Mysidacea sp. indet.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gastrosaccus spinifer	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Atylus swammerdamei	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bathyporeia pilosa	0	100	0	0	0	0	0	200	0	0	0	0	100	200
Haustorius arenarius	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gammarus salinus	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Corophium volutator	0	0	0	0	0	500	0	0	0	0	0	0	0	0
Eurydice pulchra	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pseudocuma longicornis	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carcinus maenas juveniles	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Hydrobia ulvae	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mytilus edulis	0	0	0	0	0	100	0	0	0	100	0	0	0	0
Macoma balthica	0	0	0	300	100	0	0	0	0	1200	600	0	0	100
Scrobicularia plana	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mya truncata (juveniles)	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Species abundance res

	mer01-58	mer01-57	mer01-53	mer01-25	mer01-52	mer01-51	mer01-39	mer01-29	mer01-28	mer01-27	mer01-22	mer01-19	mer01-01	mer01-02
	Core	Core	Core	Core	Core	Core	Core	Core	Core	Core	Core	Core	Grab	Grab
	AG019	AG020	AG021	AG023	AG024	AG025	AG026	AG031	AG033	AG034	AG035	AG036	AG038	AG039
Nemertean spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nemertean sp. indet. A	0	0	0	0	0	0	0	0	0	0	0	0	0	30
Nematoda spp.	0	0	0	0	0	0	100	0	0	0	0	0	0	60
Eteone longa	0	0	0	0	0	1000	200	0	0	100	0	0	0	10
Analtides mucosa	0	0	0	0	0	0	0	0	0	0	0	0	0	190
Eumida sanguinea	0	0	0	0	0	0	0	0	0	0	0	0	0	250
Glycera tridactyla	0	0	0	0	0	0	0	0	0	0	0	0	0	40
Hediste diversicolor	0	0	0	300	300	600	0	0	0	0	0	0	0	20
Nephtys spp. (incl. juveniles)	0	0	0	0	0	0	0	0	0	0	0	0	0	50
Lumbrineris sp. indet.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polydora sp.indet.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polydora ?ciliata	0	0	0	0	0	0	0	0	0	0	0	0	0	10
Polydora ?cornuta	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pygospio elegans	0	0	0	0	0	200	0	0	0	0	0	0	0	0
Spio martinensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Streblospio shrubsolii	0	0	0	0	100	0	0	0	0	0	0	0	0	0
Cirratulidae sp. indet.	0	0	0	0	0	0	0	0	0	0	0	100	0	90
Capitella sp. complex	0	0	0	0	0	0	0	0	0	0	0	0	0	10
Tubificidae spp.	0	0	0	0	800	0	200	0	100	100	0	0	0	30
Heterochaeta costata	100	0	0	200	700	100	0	0	0	0	0	0	0	340
Tubificoides benedii	100	0	0	0	7900	7400	1000	0	100	0	0	3100	0	3160
Mysidacea sp. indet.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gastrosaccus spinifer	0	0	0	0	0	0	0	0	0	0	0	0	30	0
Atylus swammerdamei	0	0	0	0	0	0	0	0	0	0	0	0	0	170
Bathyporeia pilosa	0	0	300	0	0	0	0	100	0	0	0	0	0	0
Haustorius arenarius	0	0	0	0	0	0	0	0	0	100	0	0	0	0
Gammarus salinus	0	0	0	0	0	0	0	0	0	0	0	0	0	10
Corophium volutator	0	0	0	2300	900	5200	3200	0	0	0	0	100	0	0
Eurydice pulchra	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pseudocuma longicornis	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carcinus maenas juveniles	0	0	0	0	0	0	0	0	0	0	0	0	20	0
Hydrobia ulvae	0	0	0	100	0	1200	400	0	0	0	0	0	10	0
Myltilus edulis	0	0	0	0	0	0	0	0	0	0	100	0	0	260
Macoma balthica	100	100	100	500	400	900	700	0	0	0	0	0	0	0
Scrobicularia plana	0	0	0	0	100	0	0	0	0	0	0	0	0	0
Mya truncata (juveniles)	0	0	0	0	0	100	100	0	0	0	0	0	0	10

Species abundance res

	mer01-03	mer01-05	mer01-06	mer01-10	mer01-11	mer01-13	mer01-14	mer01-15	mer01-18	mer01-23	mer01-17	mer01-20	mer01-16	mer01-12
	Grab	Grab	Grab	Grab	Grab	Grab	Grab	Grab	Grab	Grab	Grab	Grab	Grab	Grab
	AG040	AG041	AG042	AG044	AG045	AG046	AG047	AG048	AG049	AG050	AG051	AG052	AG053	AG054
Nemertean spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nemertean sp. indet. A	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Nematoda spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eteone longa	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Anaitides mucosa	10	0	0	0	0	0	0	0	0	0	0	0	0	0
Eumida sanguinea	0	10	10	0	0	0	0	0	0	0	0	0	0	0
Glycera tridactyla	0	0	10	0	0	0	0	0	0	0	0	0	0	0
Hediste diversicolor	0	30	0	0	0	0	0	0	0	0	0	0	0	0
Nephtys spp. (incl. juveniles)	0	0	20	0	0	0	0	0	0	0	0	0	0	0
Lumbrineris sp. indet.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Polydora sp.indet.	0	0	0	0	0	0	0	0	0	0	10	0	0	0
Polydora ?ciliata	0	20	0	0	0	0	0	0	0	0	0	0	0	0
Polydora ?cornuta	0	50	0	0	0	0	0	0	0	0	0	0	0	0
Pygospio elegans	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Spio martinensis	0	0	10	0	0	0	0	0	0	0	0	0	0	0
Streblospio shrubsolii	0	0	0	0	0	0	0	0	20	10	0	0	0	0
Cirratulidae sp. indet.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capitella sp. complex	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tubificidae spp.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Heterochaeta costata	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Tubificoides benedii	10	0	0	0	0	0	0	0	0	0	0	0	0	0
Mysidacea sp. indet.	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gastrosaccus spinifer	0	0	0	0	0	0	10	0	0	0	0	0	0	0
Atylus swammerdamei	0	0	0	0	30	0	0	0	0	0	0	0	0	0
Bathyporeia pilosa	0	0	0	0	0	0	0	0	0	0	0	0	0	20
Haustorius arenarius	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gammarus salinus	0	0	0	10	80	50	0	0	0	0	0	0	10	0
Corophium volutator	0	270	0	0	0	0	0	0	0	0	20	40	10	10
Eurydice pulchra	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pseudocuma longicornis	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Carcinus maenas juveniles	0	0	0	0	0	10	0	10	0	0	0	0	10	30
Hydrobia ulvae	0	0	0	0	70	0	0	0	0	0	0	0	10	0
Mytilus edulis	10	1100	130	0	0	0	0	10	0	0	0	0	0	0
Macoma balthica	0	0	20	0	0	0	0	0	0	0	0	0	0	0
Scrobicularia plana	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mya truncata (juveniles)	0	0	0	0	0	0	0	0	0	0	0	0	0	0

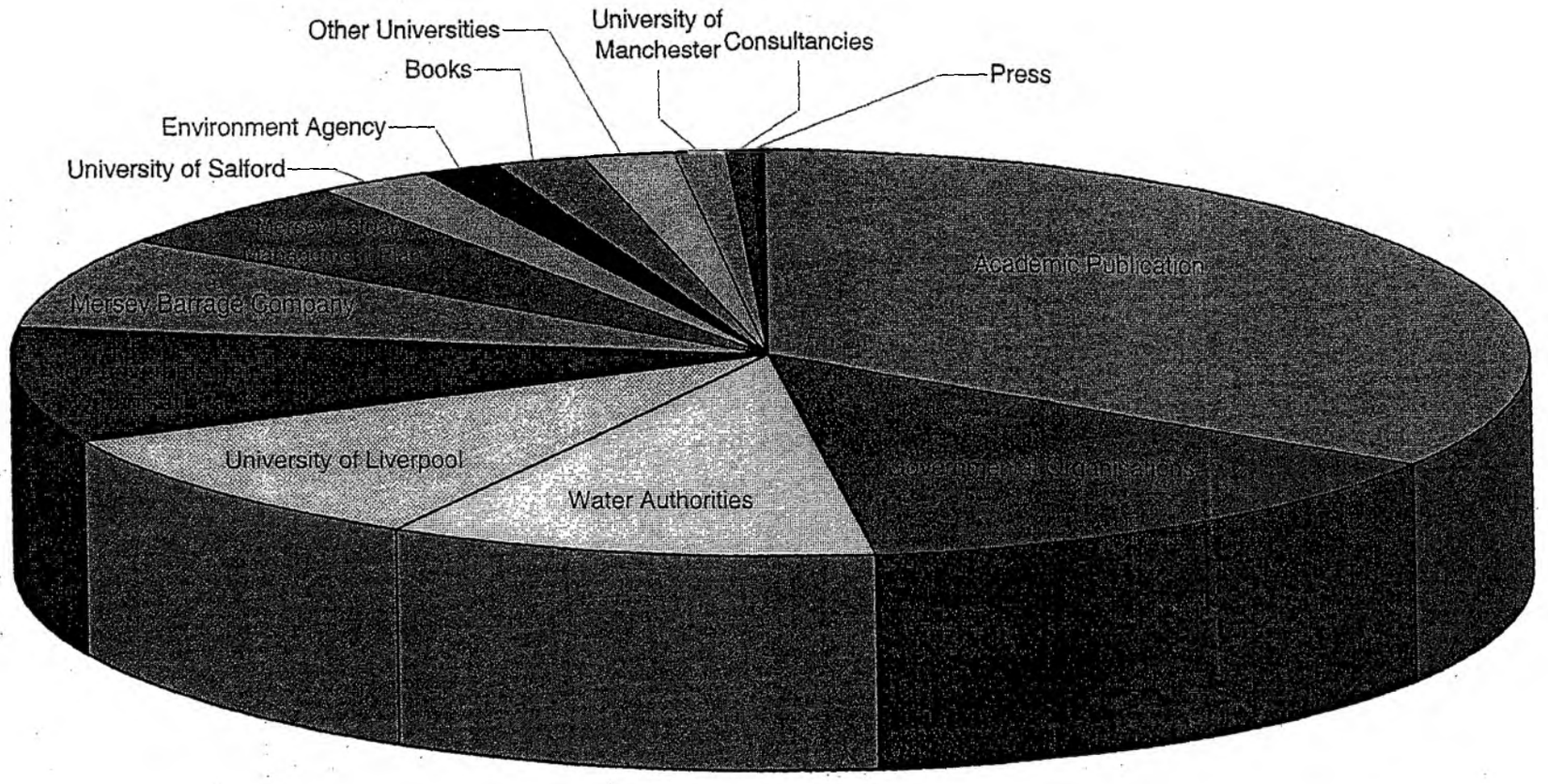
Biomass results of Environment Agency benthic survey of the Mersey (Summer 2001)

		mer01-26	mer01-37	mer01-38	mer01-50	mer01-49	mer01-56	mer01-55	mer01-48	mer01-36	mer01-35	mer01-47	mer01-46	mer01-34	mer01-33	mer01-45
MCS Code		AG001	AG002	AG003	AG004	AG005	AG006	AG007	AG008	AG009	AG010	AG011	AG012	AG013	AG014	AG015
	Cnidaria															
	Actinaria sp. indet.															
	NEMERTEA															
G0001	*Nemertean spp.*															
G0001	*Nemertean sp. indet. A*															
	NEMATODA															
HD001	*Nematoda spp.*															
	Annelida															
	Polychaeta															
P0118	*Eteone longa*												0.0004			
P0145	*Anaitides mucosa*															
P0167	*Eumida sanguinea*															
P0265	*Glycera tridactyla*															
P0461	*Hediste diversicolor*		0.0222					0.0135	0.008					0.0195		
P0494	*Nephtys spp. (incl. juveniles)*															0.0007
P0572	*Lumbrineris sp. indet.*															
P0748	*Polydora sp.indet.*															
P0752	*Polydora ?ciliata*															
P0753	*Polydora ?cornuta*															
P0776	*Pygospio elegans*		<0.0001											0.0012		
P0791	*Spio martinensis*															
P0799	*Streblospio shrubsolii*															
P0822	*Cirratulidae sp. indet.*															
P0906	*Capitella sp. complex*															
	Oligochaeta															
P1425	*Tubificidae spp.*															
P1479	*Heterochaeta costata*							<0.0001		0.0005						
P1490	*Tubificoides benedii*						0.0003									
	Crustacea															
R0077	*Balanus crenatus*															
S0025	*Mysidacea sp. indet.*															
S0044	*Gastrosaccus spinifer*															
S0412	*Atylus swammerdamei*															
S0457	*Bathyporeia pilosa*				0.001							0.0038				
S0462	*Haustorius arenarius*															
S0481	*Gammarus salinus*															
S0616	*Corophium volutator*									0.0074						
S0854	*Eurydice pulchra*															
S1236	*Pseudocuma longicornis*															
S1594	*Carcinus maenas juveniles*															
	Mollusca															
W0385	*Hydrobia ulvae*															
W1695	*Myltilus edulis*									0.0006				<0.0001		
W2029	*Macoma balthica*							0.0377	0.0223					0.4083	0.3903	
W2068	*Scrobicularia plana*															
W2147	*Mya truncata (juveniles)*															
	Bryozoa															
Y0080	*Alcyonidium mytili*															
Y0172	*Conopeum reticulum*															

Biomass results of Environmen

		mer01-32	mer01-44	mer01-54	mer01-58	mer01-57	mer01-53	mer01-31	mer01-25	mer01-52	mer01-51	mer01-39	mer01-40	mer01-41	mer01-30	mer01-29
MCS Code		AG016	AG017	AG018	AG019	AG020	AG021	AG022	AG023	AG024	AG025	AG026	AG027	AG028	AG030	AG031
	Cnidaria															
	Actinaria sp. indet.															
	NEMERTEA															
G0001	*Nemertean spp.*															
G0001	*Nemertean sp. indet. A*															
	NEMATODA															
HD001	*Nematoda spp.*											<0.0001				
	Annelida															
	Polychaeta															
P0118	*Eteone longa*										0.0018	0.0018				
P0145	*Analtides mucosa*															
P0167	*Eumida sanguinea*															
P0265	*Glycera tridactyla*															
P0461	*Hediste diversicolor*								0.0343	0.1394	0.0026					
P0494	*Nephtys spp. (incl. juveniles)*															
P0572	*Lumbrineris sp. indet.*															
P0748	*Polydora sp.indet.*															
P0752	*Polydora ?ciliata*															
P0753	*Polydora ?cornuta*															
P0776	*Pygospio elegans*										0.0002					
P0791	*Spio martinensis*															
P0799	*Strebiospio shrubsolii*									<0.0001						
P0822	*Cirratulidae sp. indet.*															
P0906	*Capitella sp. complex*															
	Oligochaeta															
P1425	*Tubificidae spp.*									0.0014		0.0002				
P1479	*Heterochaeta costata*				0.0001				0.0004	0.0013	0.0001					
P1490	*Tubificoides benedii*				0.0001					0.0224	0.0413	0.0063				
	Crustacea															
R0077	*Balanus crenatus*															
S0025	*Mysidacea sp. indet.*															
S0044	*Gastrosaccus spinifer*															
S0412	*Atylus swammerdamei*															
S0457	*Bathyporeia pilosa*		0.002	0.0008			0.0055									0.0002
S0462	*Haustorius arenarius*															
S0481	*Gammarus salinus*															
S0616	*Corophium volutator*								0.0149	0.0036	0.03	0.0151				
S0854	*Eurydice pulchra*															
S1236	*Pseudocuma longicornis*															
S1594	*Carcinus maenas juveniles*															
	Mollusca															
W0385	*Hydrobia ulvae*								0.0172		0.0381	0.0111				
W1695	*Myltilus edulis*															
W2029	*Macoma balthica*			0.4918	0.0102	0.0137	0.0147		0.0245	0.0387	0.0241	0.5534				
W2068	*Scrobicularia plana*									0.2569						
W2147	*Mya truncata (juveniles)*										0.0002	0.0005				
	Bryozoa															
Y0080	*Alcyonidium mytili*															
Y0172	*Conopeum reticulum*															

Appendix 4: Mersey Estuary Bibliography



Academic Publication	Governmental Organisations	Water Authorities
University of Liverpool	Non-governmental Organisations	Mersey Barrage Company
Mersey Estuary Management Plan	University of Salford	Environment Agency
Books	Other Universities	University of Manchester
Consultancies	Press	

Reference Type	Information Source	Date	Author/Contact	Title/Information Content	Keywords	Area of study	Comments/Summary
Academic Journal	Ringing and Migration (1994) 15: 91-97	1991	Norman D, Coffey P	The importance of the Mersey Estuary for waders in the cold weather of February 1991	Birds	New Brighton	Found weight increases in waders in mid-Feb, contrasting sharply with the drop in weights expected- suggesting waders had access to good food supplies.
Grey Literature	BTO, Research Report No. 96	1992	Holloway SJ et al.,	Dispersion of waterfowl on the Mersey in relation to their prey	Birds, Invertebrates	Mersey Estuary	Compared invertebrate (compiled from 96 intertidal samples during the winters of 1990/91 and 1991/92) and waterfowl distributions across the Mersey Estuary as part of Mersey Barrage Proposal.
Grey Literature	BTO, Research Report No. 54	1990	Clark NA et al.,	Waterfowl migration and distribution in north west estuaries	Birds	North West	
Grey Literature	BTO, Research Report No. 66	1990	Clark NA et al.,	The day and night distributions of waterfowl on the Mersey and adjacent areas	Birds	Mersey Estuary	
Grey Literature	BTO, Research Report No. 77	1994	Rehmfisch M et al	Waterfowl distribution and diet on the Mersey estuary and adjacent areas	Birds, Invertebrates	Mersey Estuary	Compared invertebrate (compiled from intertidal samples collected during the winters of 1990/91) and waterfowl distributions across the Mersey Estuary as part of Mersey Barrage Proposal.
Grey Literature	BTO, Research Report No. 62	1990	Clark NA et al.,	The impact of the Mersey oil spill of 1989 on the populations and distribution of waterfowl	Birds, Oil	Mersey Estuary	
Academic Journal	J. mar. biol. Ass.UK. 18. 69-85	1932	Fraser JH	The fauna of a polluted area in the River Mersey. .	Ecology, Water Quality	Mersey Estuary	
Academic Journal	Geophys. J. R. astr. Soc. 10. 383-399	1938	Bassindale, R.	The Intertidal Fauna of the Mersey estuary.	Invertebrates	Mersey Estuary	
Academic Journal	Estuar. Coast. Mar. Sci. 7. 117-125	1978	Moore DM	Seasonal changes in the Distibution of Intertidal Macrofauna in the Lower Mersey estuary, UK. .	Invertebrates	Mersey Estuary	
Academic Journal	Env. Poll. 31 (4). 239-259	1983	Bull KR, Every WJ, Freestone P, Hall JR, Osborn, D	Alkyl Lead Pollution and Bird Mortalities on the Mersey Estuary, UK, 1979-1981.	Birds, Inorganic, Metals, Lead	Mersey Estuary	
Academic Journal	Env. Poll. 31 (4). 261-275	1983	Osborn D, Every WJ, Bull KR	The Toxicity of Trialkyl Lead Compounds to Birds.	Birds, Inorganic, Metals, Lead		
Academic Journal	Wat. Sci. Tech. 18 (4-5). 171-180.	1986	Wilson KW, Head PC, Jones PD	Mersey Estuary Bird Mortalities - Causes, Correctives and Consequences.	Birds	Mersey Estuary	
Academic Journal	J. Fish Biol. 33. (supplement A) 235-238.	1988	Wilson KW, Darcy BJ, Taylor S	The return of fish to the Mersey estuary.	Fish	Mersey Estuary	

Reference Type	Information Source	Date	Author/Contact	Title/Information Content	Keywords	Area of study	Comments/Summary
Academic Journal	Env. Poll. 72 (2). 117-126.	1991	Leah T, Ma ZY, Evans SJ, Johnson MS	Mercury in the stomach contents of dab (Limanda limanda) from the north-east Irish Sea and Mersey estuary.	Inorganic, Metals, Mercury, Fish	Mersey Estuary	Reviewed mercury concentrations in stomach contents of dab. A decrease in the mercury content of fish food was observed which corresponds reduced inputs at Liverpool Bay sewage disposal site. Levels in Mersey similar to open sea -
Academic Journal	Mar. Pol. Bull. 22 (4). 172-175	1991	Leah RT, Evans SJ, Johnson MS.	Spatial patterns in accumulation of mercury by fish from the north-east Irish Sea.	Inorganic, Metals, Mercury, Bioaccumulation, Fish	North East Irish Sea	Compares Mercury concentrations in fish (plaice, dab & lesser-spotted dogfish) muscle tissue. Relationship between mercury concentration and fish length and the distance of site from the Mersey,
Academic Journal	Mar. Pol. Bull. 24 (11). 544-549	1992	Leah RT, Evans SJ, Johnson MS	Arsenic in plaice (Pleuronectes platessa) and whiting (Merlangius merlangius) from the north-east Irish Sea.	Inorganic, Metals, Arsenic, Bioaccumulation, Fish	North East Irish Sea	Analysed arsenic in muscle tissue. Concentrations were greater in plaice than whiting and, for both species, the highest concentrations were observed on Liverpool Bay sludge disposal site and towards IoM.
Academic Journal	Environmental Pollution. 75 (3). 317-322	1992	Leah T, Ma ZY, Evans SJ, Johnson MS	Mercury in flounder (Platichthyes flesus) from estuaries and coastal waters of the north-east Irish sea.	Inorganic, Metals, Mercury, Bioaccumulation, Fish	North East Irish Sea	Compared Mercury concentrations in Flounder from 3 NW estuaries (Mersey, Dee & Ribble) and at coastal sites in their vicinity. Observed relationship with fish length and signs of age accumulation.
Academic Journal	Marine Environmental Research. 41 (3). 281-297	1996	Collings SE, Johnson MS, Leah RT	Metal contamination in angler-caught fish from the Mersey Estuary.	Inorganic, Metals, Bioaccumulation, Fish	Mersey Estuary	Analysed muscle tissue of 6 fish species for mercury, arsenic, lead, copper, zinc, chromium and cadmium. Mercury in eel and flounder in excess of statutory limit in inner estuary. Arsenic high but of low toxicology. Other metals in expected
Academic Journal	Marine Environmental Research. 43 (4). 345-358.	1997	Leah RT, Johnson MS, Connor L Levene C.	Polychlorinated biphenyls in fish and shellfish from the Mersey Estuary and Liverpool Bay.	Organic, Organochemicals, Bioaccumulation, Fish, Invertebrates, Shellfish,	Mersey Estuary and Liverpool Bay	Measured levels of PCB's in the muscle tissue of roundfish (cod & whiting) and flatfish (dab, sole, flounder & plaice).
Academic Journal	Mar. poll. Bull. 95 (3). 303-309	1997	McNeish AS, Johnson MS, Leah RT	Methylated hexachlorocyclohexane in blue mussels (Mytilus edulis) from the Mersey and Dee Estuaries.	Organic, Organochemicals, Bioaccumulation, Invertebrates, Shellfish.	Mersey Estuary and Dee Estuary	MHCH in mussels declined from Rock Ferry to Egremont and New Brighton, with high values found at Crosby. There was evidence of biomagnification of MHCH compounds in plaice and dab.

Reference Type	Information Source	Date	Author/Contact	Title/Information Content	Keywords	Area of study	Comments/Summary
Academic Journal	Aquat. Toxicol., 40 (1). 11-12.	1997	McNeish, AS, Johnson MS, Leah RT	Methyl lindane and other analogues of hexachlorocyclohexane in dab and plaice from the Mersey estuary.	Organic, Organochemicals, Fish, Bioaccumulation	Mersey Estuary	Compares MHCH data in mussels, dab and plaice from several areas of the Mersey Estuary. Concentrations show a clear gradient from the inner Estuary out towards Liverpool Bay.
Academic Journal	Marine Environmental Research. 52 (5). 397-411	2001	Connor L, Johnson MS, Copplestone D, Leah RT	Recent trends in organochlorine residues in mussels (Mytilus edulis) from the Mersey Estuary.	Organic, Organochemicals, Invertebrates, Bioacumulation, Shellfish	Mersey Estuary	Analysed mussel concentrations of organochlorines. Inner estuary more cotaminated than outer. Comparison between 1994 and 1998 data. Lower levels recorded in 1998 thought to be early evidence of improvements in water quality
Academic Journal	Instn. Civ. Engrs. 32. 296-335	1949	Cashin, J.A.	Engineering works for the improvement of the Mersey.	Management, Development	Mersey Estuary	
Academic Journal	Geophys. J. R. astr. Soc. 1. 271-283	1958	Hughes P	Tidal mixing in the Narrows of the Mersey estuary.	Tidal Currents	Narrows	
Academic Journal	Assoc. Int. Hydrol. Sci. Pub.No. 51. 352-360	1960	Bowden KF	Circulation and mixing in the Narrows of the Mersey estuary.	Tidal Currents	Narrows	
Academic Journal	Proceedings of the Institution of Civil Engineers. 50. 473-518	1963	Price WA, Kendrick MP	Field and model investigations into the reasons for the siltation of the Mersey Estuary.	Tidal Currents, Sediments	Mersey Estuary	
Academic Journal	J. L'pool Engng. Soc. 11. No.3	1965	Halliwell AR, O'Conner BA	Flow and siltation measurements in the Mersey estuary.	Tidal Currents, Sediments	Mersey Estuary	
Academic Journal	Geophys. J. R. astr. Soc. 10. 383-399	1966	Bowden KF, Sharaf El Din SH	Circulation, salinity, and river discharge in the Mersey estuary.	Circulation, Salinity, Mixing	Mersey Estuary	
Academic Journal	Geophys. J. R. astr. Soc. 10. 421-435	1966	Hughes P	The temperature and salinity of the surface waters of the Irish sea for the period 1947-1961.	Water Quality, Salinity, Temperature	Irish Sea	
Academic Journal	Dock. Harb. Auth. 50. 125-129	1969	Halliwell R, Odell, M	Differences in silt patterns across an estuary.	Sediments	Mersey Estuary	
Academic Journal	Limnol. Oceanogr. 16. 490-502	1971	Bowden KF, Gilligan RM	Characteristic features of estuarine circulation as represented in the Mersey estuary.	Tidal Currents	Mersey Estuary	
Academic Journal	Geochim. Cosmochim. Acta. 38. 1719-1728.	1974	Boyle E, Collier R, Dengler AT, Edmond, JM, Ng AC, Stallard RF	On the chemical mass-balance in estuaries.	Water Quality		
Academic Journal	Journal of the Geological society, London. 144. 187-195.	1987	O'Connor BA	Short and long term changes in estuary capacity.	Hydrology, Tidal Currents		
Academic Journal	Estuarine Coastal Shelf Science. 45 (4). 433-451	1997	Lane A, Prandle D, Harrison AJ, Jones PD, Jarvis CJ	Measuring Fluxes in Tidal Estuaries: Sensitivity to Instrumentation and Associated Data Analysis.	Tidal currents		Tested feasibility of quantifying net fluxes across macrotidal estuary using a range of available instruments. All systems trialed in Mersey.

Reference Type	Information Source	Date	Author/Contact	Title/Information Content	Keywords	Area of study	Comments/Summary
Academic Journal	Geophysical Journal International. 136. 651-670	1999	Woodworth, P.L. Tsimplis, M.N., Flather, R.A. and Shennan, I	A review of the trends observed in the British Isles mean sea level data measured by tide gauges.	Sea level rise		Review, by Proudman Oceanographic Lab., of datasets from tide gauges and their value for monitoring sea level chnages.
Academic Journal	Geophysical research Letters. 26 (11). 1589-1592.	1999	Woodworth, P.L.	High waters at Liverpool Since 1768: The UK's longest sea level record.	Sea level rise		Identifies high water information from Liverpool as arguably second oldest in the world. Time series for 'adjusted mean high water; is available back to 1768. Trends = +0.39mm/yr to 1880 and +1.22mm/yr in 20th Cent' (acceleration in 2nd half of 20th C')
In press	In Press		Wither AW, Jarvis CJ, Jones PD, Land JA	A New Technique for Contaminant Flux Measurement in Estuaries.	Water Quality, Tidal Currents		
In press	In Press		Land JM, Jones PD	Acoustic Measurement of Sediment Flux in rivers and near-shore Waters	Sediments		
In press	International Journal of Climatology		Woodworth, P.L. and Blackman, D.L.	Changes in extreme high waters at Liverpool since 1768	Sea level rise, Tidal Currents, History	Liverpool	
Academic Journal	Roy Soc. of Health	1963	Woodward, R.E	The Pollution of the River Mersey.	Pollution, Water Quality	Mersey Estuary	
Academic Journal	Effl. Wat. Treat. J. 7. 365-374.	1967	O'Connor BA, Croft JE	Pollution in a tidal estuary.	Pollution, Water Quality	Mersey Estuary	
Academic Journal	Estuar. Coast. Mar. Sci. 1. 401-409.	1973	Abdullah MI, Royle LG	Chemical evidence for the dispersal of River Mersey run-off in Liverpool Bay.	Pollution, Water Quality	Mersey Estuary and Liverpool Bay	
Academic Journal	Proc. Royal soc of London (B) 189. 305-322.	1975	Pearson CR, McConnell G	Chlorinated C1 and C2 hydrocarbons in the Marine environment.	Organic, Organochemicals, Water Quality, Pollution		
Academic Journal	Nature. 261. 125-126.	1976	Craig PJ, Morton SF	Mercury in Mersey estuary sediments and the analytical procedure for total mercury.	Inorganic, Metals, Mercury, Sediments	Mersey Estuary	
Academic Journal	J. Instn. Wat. Engrs. and Sci. 31. 307-	1977	Lloyd JG, Oldfield JB	Planning for Cleaning Up an Estuary. Part I. Concepts and Organisation.	Management, Water Quality	Mersey Estuary	
Academic Journal	J. Instn. Wat. Engrs. and Sci. 31. 329-	1977	Gouge RL, Symes GL, Buckley AD	Planning for Cleaning Up an Estuary. Part II. Physical planning for the Mersey.	Management	Mersey Estuary	
Academic Journal	Intern. J. Environmental Studies. 14. 299-308	1980	Karthegisan J, Pugh Thomas M	The Effect of Tidal Heights on the Distribution and Abundance of Coliform Bacteria in the Sediments of the Mersey Estuary.	Tidal Currents, Bacteria, Sediments	Mersey Estuary	
Academic Journal	Roy. Soc. of Health. 102 (5). 211-217	1982	Alexander B.	Future Improvements to the Mersey Estuary	Management, Socioeconomic	Mersey Estuary	

Reference Type	Information Source	Date	Author/Contact	Title/Information Content	Keywords	Area of study	Comments/Summary
Academic Journal	Water Research 16(5): 565-578.	1982	Airey D, Jones PD	Mercury in the River Mersey, its estuary and tributaries during 1973-74.	Inorganic, Metals, Mercury, Water Quality	Mersey River, Estuary and Tributaries	
Academic Journal	Mar. Pol. Bull. 15 (4) 153-158	1984	Riley JP, Towner JV	The distribution of alkyl lead species in the Mersey Estuary.	Inorganic, Metals, Lead	Mersey Estuary	
Academic Journal	Water Air Soil Pollut. 22 (3). 241-255.	1984	Dillon EJ, Hendersonsellers B	A bacteriological assessment of the Mersey estuary and north Wirral Coast, UK.	Bacteria	Mersey Estuary and North Wirral Coast	
Academic Journal	Wat. Sci.Tech. 17 (8). 1363-1365.	1985	Whitelaw K, Cole JA, Head PC, Jones, PD	Tidal Fluxes of Metals through the Mersey Estuary.	Inorganic, Metals, Tidal Currents	Mersey Estuary	
Academic Journal	J. Instn. Wat Engrs and Sci. 39. 410-413	1985	Dixon, A	The Mersey estuary pollution alleviation scheme.	Management, Pollution, Water Quality	Mersey Estuary	
Academic Journal	Wat. Sci. Tech. 18. 354-	1986	Whitelaw K, Cole JA, Head PC, Jones, PD	Fluxes of dissolved and particulate arsenic, cadmium and chromium through the Mersey estuary (UK) and their variation with tidal range.	Inorganic, Metals, Arsenic, Cadmium, Chromium, Tidal Currents		
Academic Journal	Mar. Poll. Bull. 17 (1). 36-40.	1986	Campbell, J.A., Chan, E.Y.L., Riley, J.P., Head, P.C. and Jones, P.D	The Distribution of Mercury in the Mersey Estuary.	Inorganic, Metals, Mercury	Mersey Estuary	
Academic Journal	Estuarine Coastal Shelf Science. 23 (2). 239-261.	1986	Langston WJ	Metals in sediments and benthic organisms in the Mersey Estuary.	Inorganic, Metals, Sediments, Bioaccumulation, Invertebrates	Mersey Estuary	
Academic Journal	Sci. Tot. Env. 49. 257-295.	1986	Taylor D	Changes in the distribution patterns of trace metals in the sediments of the Mersey Estuary in the last decade.	Inorganic, Metals, Sediments, History	Mersey Estuary	
Academic Journal	Mar. Poll. Bull. 17 (12). 548-553.	1986	Preston MR, Alomran LA	Dissolved and particulate phthalate esters in the River Mersey estuary.	Organic, Organochemicals, Phthalates	Mersey Estuary	
Grey Literature	IWEM Handbook	1988	Glegg D	The Campaign to Clean-up the Mersey.	Management, Pollution, Water Quality	Mersey Estuary	
Academic Journal	Sci. Tot. Environ. 71 (2). 141-155	1988	Campbell, J.A., Whitelaw, K., Riley, J.P., Head, P.C. and Jones, P.D.	Contrasting Behaviour of Nickel and Zinc in a Polluted Estuary.	Inorganic, Metals, Nickel, Zinc	Mersey Estuary	
Academic Journal	Wat. Sci. Tech. 20. 229-233.	1988	Hockin OC, Parker DM	The effects of development of a tidal barrage upon the water and sediment quality of the Mersey estuary (UK).	Sediments, Development, Water Quality		
Academic Journal	Mar. Poll. Bull. 20. 480.	1989	Hall-Spencer J	Pipeline leak into the Mersey.	Pollution, Water Quality	Mersey Estuary	

Reference Type	Information Source	Date	Author/Contact	Title/Information Content	Keywords	Area of study	Comments/Summary
Academic Journal	Wat. Sci. Tech. 21. 1489-1498.	1989	Alexander B, and Harper E	The Mersey Basin Campaign - the technical challenge.	Management, Water Quality, Mersey Basin Campaign	Mersey Estuary	
Academic Journal	Env. Poll. 62. 183-193.	1989	Preston MR, Alomran LA	Phthalate ester speciation in estuarine water, suspended particulates and sediments.	rganic, Organochemicals, Phthalates, Sediments	Mersey Estuary	
Academic Journal	Mar. Poll. Bull. 21. 481-484.	1990	Davies RJ, Wolff GA	The Mersey oil spill, August 1989 - A case of sediments contaminating the oil?	Organic, Organochemicals, Oil, Pollution, Sediments		
Academic Journal	Analytical Chimica Acta. 245 (2). 167-176.	1991	Yokoi, K. and van den Berg, C.M.G.	The chemical speciation of titanium in sea water using catalytic cathodic stripping voltametry.	Inorganic, Metals, Titanium		Review of titanium levels in the Mersey. Higher concentrations in low salinity areas and conservative in behaviour (with some removal at low salinities).
Academic Journal	Estuarine Coastal Shelf Science. 34 (1). 37-48.	1991	Preston MR, Prodduturu P	Tidal variations of particulate carbohydrates in the Mersey Estuary.	Organic, Organochemicals, Carbohydrates, Tidal Currents		
Academic Journal	Env. Poll. 81 (1). 7-13.	1993	Preston MR, Raymundo CC	The associations of linear alkyl benzenes with bulk properties of sediments from the River Mersey Estuary.	Inorganic, Organic, Organochemicals, Sediments	Mersey Estuary	Concentration of alkyl benzenes (LAB) reported as function of grain size and and organic carbon and lipid concentration at 3 sites. LAB concentrations in Mersey are relatively high and show signs of degradation from high bacterial activity in the system
Academic Journal	Mar. Poll. Bull. 24. 82-91.	1992	Rogers HR, Crathorne B, Watts CD	Sources and Fates of Organic Compounds in the Mersey Estuary: Volatile Organohalogen Compounds.	Organic, Organochemicals, Water Quality	Mersey Estuary	Studied the concentrations and distribution of volatile oganohalogen compounds (VOCls). Manchester Ship Canal and R. Weaver identified as important sources. Concentrations decline seawards indicating loss (possibly through volatilisation).
Academic Journal	Marine Chemistry. 58. 73-83	1997	Osborne PJ, Preston MR, Chen N	Azaarenes in sediments and the aerosol of the River Mersey Estuary.	Inorganic, Organic, Organochemicals, Sediments	Mersey Estuary	
Academic Journal	Marine Environmental Research. 47. 311-329.	1999	Fox MF, Johnson MS, Leah RT, Copplestone D	The use of sediment cores from stable and developing saltmarshes to reconstruct historical pollution profiles in the Mersey Estuary.	Pollution, Sediments, Saltmarsh	Mersey Estuary	Sediment profiling used to 'map' historical trends in organochlorine pollution. Quantities in the reservoir of pollutants under these marshes have fallen in the last 30-50 years.

Reference Type	Information Source	Date	Author/Contact	Title/Information Content	Keywords	Area of study	Comments/Summary
Academic Journal	Proc. Instn. Civ. Engrs. 136. 171-183.	1999	Olsen GN, Danbury MF, Leatherbarrow B	The Mersey estuary pollution alleviation scheme: Liverpool interceptor sewers.	Management, Pollution, Development, Water Quality, Sewage	Mersey Estuary	
Statutory Authority Document	Environment Agency Report	2001	Environment Agency	Water Quality Monitoring in the Mersey	Organic, Organochemicals, Water Quality, Oxygen, Nutrients, Metals, Turbidity	Mersey Estuary	Contains data set from mid 60's (02, BOD, nutrients, suspended solids) current data also includes metals and organic compounds.
University Thesis	MSc Thesis, University of Wales, Cardiff	1997	Hering, Ruth	The fish of the Mersey Estuary from 1981-97 caught using a 2m beam trawl; an analysis of results and review of sampling procedures	Fish, Water Quality	Mersey Estuary	Fish data from beam trawls at 5 estuary sites beteween 1981 and 1997 were analysed to detect any evidence of long-term changes in the popn which might reflect water
University Thesis	MSc Thesis, University of Liverpool	1931	Fraser JH	The fauna and flora of the Mersey Estuary with special reference to pollution and sedimentary deposits	Ecology, Pollution, Water Quality, Sediments	Mersey Estuary	Describes the fauna and flora at 9 sites along the Mersey estuary, correlated with the physical conditions and the effects of
Grey Literature	NWW, Rivers Division Report	1979	D'arcy BJ	Bird mortality on the Mersey estuary	Birds	Mersey Estuary	Data collected following a large bird mortality event during Autumn/Winter 1979.
Grey Literature	Imperial Chemical Industries Limited, Brixham Laboratory	1980	Craig NCD, Tapp JF, Taylor D	An investigation of the inner Mersey estuary in connection with the 1979 bird mortality incident	Birds, Invertebrates, Pollution	Mersey Estuary	Analysed chemical content of bird carcasses from 1979 mortality, surveyed benthic infauna and diet preferences of Dunlin, the species most severely affected.
Grey Literature	North West Water rivers division, BSc Honours Dissertation	1981	Hywell-Jones NL	A study of growth, age and distribution of Macoma balthic on Dungeon Bank, Mersey estuary.	Invertebrates	Dungeon Bank, Eastham and Weaver Sluices	Surveyed distribution and abundance of the bivalve mollusc, M. Balthica in the Mersey estuary, specifically Dungeon Bank. Looked at age, length and weight distribution up the
Grey Literature	North West Water, preliminary report DSS-EST-80-1	1980	Head PC, D'arcy BJ , Osbaldeston PJ	The Mersey Estuary Bird Mortality Autumn/Winter 1979-80 Preliminary report	Birds, Bioaccumulation, Inorganic, Metals, Lead	Oglet-Hale Marsh (N Bank) Weaver-Gowy (S)	Determines that 1979 Bird Mortalities were a result of consuming prey with high levels of Trialkyl lead but is inconclusive as to the pathways involved.
Grey Literature	University of Salford report to North West Water	1980	Pugh Thomas M	The Ecology of the Mersey estuary.	Ecology		
Grey Literature	North West Water, rivers division report TS-BS-80-4	1980	Williams B	Observations on the occurrence and distribution of invertebrates in part of the Mersey estuary November 1979	Invertebrates, Water Quality, Oxygen, Salinity		26 sites sampled (12 shore, 14 offshore), concluded that salinity and dissolved oxygen levels were main factors affecting invertebrate distribution, found no toxic 'hot spots'

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Published Book	North West Water, rivers division report TS-DS-82-4	1982	D'arcy BJ	Wildlife in the Mersey estuary: Notes on the natural history of the estuary with regard to pollution past and present.	Ecology, History	Mersey Estuary	General overview of birds, invertebrates, fish and plants in the estuary and the narrows.
Grey Literature	North West Water, rivers division report TS-BS-85-3	1985	Lever, SC	The Macrobenthos of the Mersey Estuary- a return to the 1930's?	Ecology, History	Mersey Estuary	Reviews the biological changes on the Mersey estuary between 1930 and 1981,variation in species diversity over time and common species abundance changes across the
Grey Literature	North West Water, rivers division report TS-BS-83-3	1983	Taylor S	The Fish of the Mersey Estuary. Report No.1- Intake Screens	Fish, Tidal Currents, Water Quality	Mersey Estuary	Monitored Mersey estuary fish populations by identifying fish removed by screening at Ince & Runcorn power stations. Abundance & diversity varied with season, tide & water quality
Grey Literature	North West Water, rivers division report TS-BS-83-4	1983	Taylor S	The Fish of the Mersey Estuary. Report No.2- Migratory Fish	Fish, Ecology	Mersey Estuary	examined the Mersey estuary tributaries for presence of migratory fish species.Of the 8 streams sampled. Only 3 contained a varied fish population and migrant species.
Grey Literature	North West Water, rivers division report TS-BS-85-2	1985	Taylor S	The Fish of the Mersey Estuary. Report No.3- Trawling	Fish, Pollution, Water Quality	Mersey Estuary	15 species of fish were recorded in the Mersey estuary, in good condition. The total species list and the variation from one site to another may reflect pollution load.
Academic Journal	J. Mar. Biol. Assoc. of the UK. 62(3) 667-684	1982	Langston WJ	The distribution of Mercury in British Estuarine Sediments and its availability to deposit-feeding bivalves	Inorganic, Metals, Sediments, Bioaccumulation, Invertebrates	Mersey Estuary	
Academic Journal	Env. Toxicology and Water Quality 12 (3): 223-229	1997	Leah RT, Johnson MS, Connor L, Levene CF	DDT group compunds in fish and shellfish from the Mersey Estuary and Liverpool Bay	Organic, Organochemicals, Biaoccumulation, Fish, Shellfish, Invertebrates	Mersey Estuary and Liverpool Bay	Measured DDT in tissue of flounder. Significantly higher than in outer Liverpool bay and Irish Sea. Also higher than Thames, Scotland, Channel and France. Especially high at Garston and in plaice, D sole, dab and inverts. Lower in cod & whiting.
Academic Journal	Hydrology and Earth Systems Sciences 5 (1): 103-118	2001	Cole JA, Whitelaw K	Metal Fluxes in the Mersey Narrows	Tidal Currents, Inorganic, Metals, Salinity,Turbidity	Mersey Narrows	Measured tidal fluxes of suspended and dissolved matter, particularly heavy metals, from over 300 water samples per survey at all states of the tide. Generally showed a net export to sea except during spring tides when a reverse flux was in evidence.

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Academic Journal	Proc. Inst. Civil Engineers 121 (2): 67-77	1997	Olsen, GN	Liverpool's drainage history:Seventeenth century to MEPAS	History, Development, Pollution	Mersey Estuary	Outlines the development of Liverpool's drainage and sewerage systems from 17th century to the present.contains summary of MEPAS (Mersey Estuary Pollution Alleviation Scheme)
Academic Journal	Science of the Total Environment 279 (1-3): 231-231	2001	Harland, BJ, Taylor, D, Wither A	The distribution of Mercury and other trace metals in the sediments of the Mersey estuary over 25 years 1974-1998	Inorganic, Metals, Mercury, Sediments, History	Mersey Estuary	
Academic Journal	Science of the Total Environment 253 (1-3): 45-62	2000	Harland, BJ, Taylor, D, Wither K	The distribution of Mercury and other trace metals in the sediments of the Mersey estuary over 25 years 1974-1998	Inorganic, Metals, Mercury, Sediments, History		Metals in Mersey sediments have been monitored for 25yrs. Concentrations correlated with organic matter and particle size rather than sites of discharges. Trend of continual decline but remobilisation of saltmarsh sediments
Academic Journal	Water Science and Technology 40 (10): 131-136	1999	Jones T	The Mersey Basin Campaign	Management, Water Quality, Mersey Basin Campaign	Mersey Estuary	Campaign bringing together local authorities, business, voluntary organisations and government agencies to deliver water quality improvements and regenerate Mersey Basin Campaign area
Academic Journal	J. Chatr. Inst. Wat. Env. Man. 11(1):1-7	1997	Struthers WAK	From Manchester Docks to Salford Keys: Ten years of environmental improvements in the Mersey Basin campaign area	Management, Water Quality, Mersey Basin Campaign	Mersey Estuary	Describes the development of Salford Keys and the water-treatment system installed to clean water from the Manchester Ship Canal.
Academic Journal	J. Env. Monitoring 3(1):37-42	2001	Le Roux SM, Turner A, Millward GE, Ebdon L, Appriou P	Partitioning of Mercury onto suspended sediments in estuaries	Inorganic, Metals, Mercury, Sediments		compares sediment levels of Mercury between 3 UK estuaries-Mersey,Plym and Beaulieu. Found reactivity of Mercury was affected by dissolved organic matter, salinity and sediments
Academic Journal	Marine Biology	2000	Schratzberger M, Rees HL, Boyd SE	Effects of simulated deposition of dredged material on structure of nematode assemblages- the role of	Meiofauna, Sediments		Exposed estuarine nematode assemblages to uncontaminated, oxic intertidal mud and anoxic sediments from the Mersey and Tees
Academic Journal	Marine Pollution Bulletin 40(9):780-791	2000	Kirby MF, Morris S, Hurst M, Kirby SJ, Neall P, Tylor T, Fagg A	The use of cholinesterase activity in Flounder (Platichthys flesus) muscle tissue as a biomarker neurotoxic contamination in UK estuaries	Organochemicals, Fish, Bioaccumulation, Water Quality		Investigates the occurrence and levels of neurotoxic contamination in UK estuaries.determined that reductions on cholinesterase activity were caused by contaminants

Reference Type	Information Source	Date	Author/Contact	Title/Information Content	Keywords	Area of study	Comments/Summary
Academic Journal	Est. Coastal and Shelf Science 50(3) 355-371	2000	Turner A	Trace metal contamination in sediments from UK estuaries: an empirical evaluation of the role of hydrous iron and manganese oxides	Inorganic, Metals, Sediments		Concentrations of reducible trace metals determined in sediments from contrasting UK estuaries, specifically those receiving inputs from urbanised and industrialised catchments.
Academic Journal	Marine Pollution Bulletin 38(8): 676-686	1999	Kirby MF, Matthiessen P, Neall P, Tylor T, Allchin CR, Kelly CA, Maxwell DL	Hepatic EROD activity in Flounder (Platichthys flesus) as an indicator of contaminant exposure in English estuaries	Fish, Organochemicals, Bioaccumulation		Investigates the presence of sub-lethal contaminant effects in flounder populations, from the 7 estuaries studied the Mersey had the highest mean EROD activity.
Academic Journal	Science of the Total Environment 233(1-3):5-20	1999	Allen Y, Matthiessen P, Scott AP, Hayworth S, Feist S, Thain JE	The extent of oestrogenic contamination in the UK estuarine and marine environments- further surveys of flounder	Fish, Organic, Organochemicals		surveyed vitellogenin and reproductive abnormalities in flounder, found extremely high VTG concentrations in Mersey male fish- 9% contained ovotestis.
Academic Journal	Marine Pollution Bulletin 38(2):109-118	1999	Blackburn MA, Kirby SJ, Waldock MJ	Concentrations of alkyphenol polyethoxylates entering UK estuaries	Organic, Organochemicals, Water Quality		Measured oestrogenic degradation products of alkyphenol polyethoxylate in water and sediments from estuaries, levels in the Mersey may be sufficient to effect fish
Academic Journal	Marine Pollution Bulletin 36(8):631-642	1998	Blackburn MA, Thain JE, Waldock MJ	Assessment of water quality in estuarine and coastal waters of England and Wales using a contaminant concentration technique	Organochemicals, Invertebrates, Water Quality		Measured the toxic effects of non-polar organic contaminants in water from 40 estuarine, nearshore and offshore sites- indicated that hydrocarbons may contribute to
Academic Journal	Mar. Ecol. Prog. Ser. 162:183-190	1998	Lindley JA, George CL, Evans SV, Donkin P	Viability of calanoid copepod eggs from intertidal sediments: a comparison of three estuaries	Invertebrates, Sediments		found that only 14% of calanoid copepod eggs from the Mersey hatched compared to 92% from the Exe estuary- results consistent with reduction in egg viability with increased pollution
Academic Journal	Marine Environmental Research 41 (3):241-263	1996	Camacholbar VF, McEvoy J	Total PCB's in Liverpool bay sediments	Organochemicals, Sediments	Liverpool Bay	Highest PCB levels found in muddy deposits near the river Mersey, found to be the main source of PCB's to Liverpool Bay
Academic Journal	Marine Pollution Bulletin 30 (12):851-860	1995	Comber SDW, Gunn AM, Whalley C	Comparison of the partitioning of trace metals in the Humber and Mersey estuaries	Inorganic, Metals, Water Quality, Sediments	Mersey Estuary and Humber Estuary	Found that removal of zinc, chromium, copper and cadmium from a dissolved state to suspended solids occurred in the low salinity
Academic Journal	Estuarine Coastal Shelf Science 40 (1):67-85	1995	Laslett RE	Concentrations of dissolved and suspended particulate Cd, Cu, Mn, Ni, Pb and Zn in surface waters around the coasts of England and Wales and in adjacent seas	Inorganic, Metals, Cadmium, Nickel, Lead, Zinc, Water Quality, Sediments		Sampled 6 major UK estuaries- Mersey contained the highest Cd and Ni concentrations, attributed to anthroprogenic inputs

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Academic Journal	Marine Pollution Bulletin 28 (5): 291-298	1994	Dawes VJ, Waldock MJ	Measurement of volatile organic-compounds at UK national monitoring plan stations	Organochemicals		Measured concentration and distribution of 13 volatile organic compounds from UK estuaries and offshore sites- highest concentrations were at sites close to industrial sources
Academic Journal	Environmental Pollution 76(2):89-131	1992	Bryan GW, Langston WJ	Bioavailability, accumulation and effects of heavy metals in sediments with special references to United Kingdom estuaries- a review	Inorganic, Metals, Sediments, Bioaccumulation, Invertebrates, Birds		Discusses the biological effects of Metals in the Mersey, Loughor, Severn, Fal, Poole Harbour and S'ton Water. Examples of deleterious effects from metals on inverts rare. Few instances in which impacst to birds directly related to metals.
Academic Journal	Water Science and Technology 24(10):127-134	1991	Law RJ, Fileman TW, Matthiessen P	Phthalate-esters and other industrial organic-chemicals in the North and Irish Seas	Organic, Organochemicals, Water Quality		Determined concentrations of a range of industrial organic chemicals in surface waters near 5 UK estuaries, found highest concentrations within estuaries. Ecotoxicological assessment made
Academic Journal	Water Science and Technology 24(10):143-146	1991	Allchin CR	Concentrations of alpha-hexachlorocyclohexane and gamma-hexachlorocyclohexane (lindane) in the coastal waters of England and Wales	Organochemicals, Water Quality		Determined concentrations of alpha- and gamma-hexachlorocyclohexane from several sites, levels in inshore waters were generally low and declined on moving offshore
Academic Journal	Science of the Total Environment 209(2-3):193-199	1998	Lead JR, Hamilton-Taylor J, Davison W	The effect of sequential extractions of particulate matter on trace metal sorption and microbial cell stability	Inorganic, Metals, Water Quality		Sequential extractions were performed on suspended particulate matter from the River Mersey-metal binding was found to decrease as the material was successively extracted
Academic Journal	Analytical Chimica Acta 268(2):195-204	1992	Ahel M, Evans KM, Fileman TW, Mantoura RFC	Determination of atrazine and simazine in estuarine samples by high-resolution gas-chromatography and nitrogen selective detection	Organochemicals, Water Quality	River Tamar, Thames and Mersey	Sampled estuarine waters of the River Tamar, Thames and Mersey for atrazine and triazene herbicides, developed methods for determining ultra trace concentrations of the herbicides
Academic Journal	Journal of Hydrology 165 (1-4):45-84	1995	Tellam JH	Hydrochemistry of the saline groundwaters of the lower Mersey basin permo-triassic sandstone aquifer, UK	Water Quality, Salinity, Groundwater		Discusses the salinity of groundwater in the triassic sandstones of the northern end of the Cheshire Basin and its possible origins and processes of dilution
Academic Journal	Journal of Hydrology 161(1-4):287-325	1994	Tellam JH	The groundwater chemistry of the lower Mersey basin permo-triassic sandstone aquifer system, UK- 1980 and pre-industrialisation urbanisation	Groundwater, Water Quality		Looks at what controls the groundwater chemistry of the Mersey basin and the effects of heavy urbanisation and industrialisation on the sandstone aquifer

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Grey Literature	The Mersey Estuary Conservation Group	1995	Curtis MS, Wallace ID, Norman D	The Mersey Estuary- Naturally Ours: a series of contributions written for the Mersey Estuary Conservation Group	Ecology, Birds, Saltmarshes, Socioeconomic	Mersey Estuary	Sections include; Economic History, Habitat Changes, Natural History, Wildfowl and Waders, Gulls and Terns, Saltmarshes, Influence of Man, Conservation and Development
Published Book	Hamilton Oil Company Ltd.	1993	Taylor PM (field studies council research centre), Parker JG (Hamilton Oil)	The Coast of North Wales and North West England: An Environmental Appraisal	Ecology, Hydrology, Socioeconomic	North West Coast	Describes the geology, oceanograpy and biology of the NW coastline and estuaries ans explains how commerce, recreation and conservation make use of the coastal resources
Published Book	Shell UK Ltd. Report by the Environmental Advisory Unit Liverpool University	1987	Rice KA, Putwain PD	The Dee and Mersey Estuaries: Environmental Background	Ecology, Hydrology, Socioeconomic	Mersey Estuary and Dee Estuary	General report summarising available information on the physical characteristics of the area, ecology of the estuaries and the effects of human activities on the coastline.
Academic Journal	Water Pollution Research, technical paper 7 H.M.S.O	1961	Department of Scientific and Industrial Research	The effect of the discharge of crude sewage into the estuary of the River Mersey on the amount and hardness of the deposit in the estuary	Organic, Sewage	Mersey Estuary	
Academic Journal	Proc. Trans.Lpool Biol. Soc. 56 2-28	1948	Corlett J	Rates of settlement and growth of the 'pile' fauna of the Mersey Estuary	Invertebrates	Mersey Estuary	
Grey Literature	Biological Report of the Mersey and Weaver River Authority 48:1-11	1971	Holland DG	A preliminary survey of the macrofauna of the Mersey Estuary	Invertebrates	Mersey Estuary	
Grey Literature	115th meeting of the British Association Liverpool, Lpool Uni.Press	1953	Powell TGE	Merseyside- A Scientific study of Merseyside.	Ecology	Mersey Estuary	
Academic Journal	Water Pollution Research, technical paper 7 H.M.S.O	1938	Department of Scientific and Industrial Research	Estuary of the River Mersey: The effect of the discharge of crude sewage on the deposit in the estuary	Sewage, Sediments	Mersey Estuary	
Grey Literature	Lancs. and Western Sea Fisheries Joint Committee	1972	O'Sullivan JA	Pollution and Fisheries in the Mersey Estuary and adjacent coastal waters	Fisheries, Pollution, Water Quality	Mersey Estuary and Coast	
Grey Literature	NERC Publications series 'C' No.14	1975	Liverpool Bay Study Group	Liverpool Bay- An Assessment of Present Knowledge	Ecology, Invertebrates, Phytoplankton, Zooplankton, Socio-Economic	Liverpool Bay	sections in report include; Synopsis, Phytoplankton studies, Zooplankton, Benthic marine algae, Benthic and littoral fauna, Saltmarshes, The human influence on Liverpool Bay
Statutory Authority Document	Met.Borough of Wirral, Dept.of Leisure Services and Tourism	1989	Worthington JA, (Met.Borough of Wirral)	The Wirral Coast Management Policy	Ecology, Management, Leisure, Fisheries, Birds	Wirral Coast	Sections in report include; Visitors to the coast, Activities, Nature Conservation, Commercial Fishing, Coastal Protection, Coastal Pollution, Area Action Plans, Maps

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Statutory Authority Document	Wirral Borough Council, Dept.of Housing and Env. Protection	1987	Wirral Borough Council, Dept.of Housing and Env. Protection	Bacteriological Results for Sea Water Sampling around Wirral's Coastline	Bacteria	Wirral Coast	
Grey Literature	Central Electricity Generating Board, Reports (RD/L/3338/R88)	1988	Bamber RN	A survey of the intertidal soft-sediment fauna of the Mersey Estuary	Invertebrates	Mersey Estuary	
Grey Literature	National Museums and Art Galleries on Merseyside (reports)	1990	Wilkinson S, Allen NJ, Hawkins SJ	Flora and Fauna of the Mersey Estuary: A survey of 7 Merseyside docks and New Brighton marine lake, with some info.on the zooplankton of the lower Mersey	Flora, Fauna, Zooplankton		
Academic Journal	Proc. Lpool. Biol. Soc 51:1-21	1938	Fraser JH	The fauna of fixed and floating structures in the Mersey Estuary and Liverpool Bay	Fauna	Mersey Estuary, Liverpool Bay	
Academic Journal	Proc. Int.Oil Spill Conference, American Petroleum Inst: 299-303	1991	Taylor PM	A pipeline spill into the Mersey Estuary, England	Oil	Mersey Estuary	
University Thesis	BSc Honours Botany Thesis, University of Liverpool	1969	Sharples EJ	A preliminary survey of the plankton of the River Mersey with special reference to phytoplankton	Zooplankton, Phytoplankton	Mersey Estuary	
Published Book	University of Liverpool, Liverpool University Press	1949	Allison JE	The Mersey Estuary	Mersey Estuary	Mersey Estuary	
Statutory Authority Document	National Rivers Authority, Water Quality Series 23	1995	National Rivers Authority	The Mersey Estuary: A report on environmetal quality		Mersey Estuary	
Published Book	Mersey Basin Campaign, Liverpool University Press	1995	Mersey Basin Campaign	Mersey Estuary Management Plan: a strategic policy framework	Management Plan	Mersey Estuary	
Grey Literature	National Remote Sensing Centre, SPI division SP(89) WP35	1989	Pilling I.	Sandbank mapping in the Mersey estuary: Final Report May 1989	Sediments	Mersey Estuary	
University Thesis	PhD Thesis, University of Liverpool	1968	Gilligan RM	Circulation and mixing in the Mersey estuary	Tidal Currents	Mersey Estuary	
University Thesis	PhD Thesis, University of Liverpool	1991	Jemmet AWL	An investigation into the heavy metals, sediment and vegetation of a Mersey estuary saltmarsh	Inorganic, Metals, Sediment, Saltmarsh	Mersey Estuary	
Grey Literature	Liverpool Geological Society	1920	Maidwell FT	Some borings through the marshes bordering the southern shore of the Mersey estuary	Physical	Mersey Estuary	
Grey Literature	North West Water Authority, final report	1984	Riley JP, Campbell J	A study of the distribution of selected trace metals in the waters and suspended particulate matter of the Mersey Estuary	Inorganic, Metals, Turbidity, Water Quality, Sediments	Mersey Estuary	

Reference Type	Information Source	Date	Author/Contact	Title/Information Content	Keywords	Area of study	Comments/Summary
University Thesis	PhD Thesis, University of Liverpool	1969	Hewitt C	Silt distributions and siltation processes (with particular reference to the Mersey Estuary and dock systems)	Sediments	Mersey Estuary	
University Thesis	M.Eng Thesis, University of Liverpool	1969	Hewitt C	The development of a Mathematical model of the Mersey Estuary	Tidal Currents	Mersey Estuary	
University Thesis	M.Eng Thesis, University of Liverpool	1966	Burke C	The distribution of velocity in tidal flows (Mersey Estuary)	Tidal Currents	Mersey Estuary	
University Thesis	PhD Thesis, University of Liverpool	1941	Fraser JH	An ecological survey on the inshore grounds of the Liverpool district, with special reference to the biological conditions in the Mersey Estuary	Ecology	Mersey Estuary	
University Thesis	MSc. Thesis, University of Liverpool	1947	Corlett J	Studies on the sedentary marine fauna of the Mersey estuary	Invertebrates	Mersey Estuary	
University Thesis	PhD Thesis, University of Liverpool	1995	McNeish AS	Methylated cyclic organochlorines in fish and shellfish from the Mersey Estuary	Organic, Organochemicals, Bioaccumulation, Fish, Invertebrates, Shellfish	Mersey Estuary	
Academic Journal	PhD Thesis, University of Manchester	2000	Alsop AL	An investigation of sedimentary humic acids isolated from the Mersey and Dee estuaries	Organochemicals, Sediments	Mersey Estuary and Dee Estuary	
University Thesis	Thesis, University of London	1992	Pereira CMC	Some aspects of Mercury and Selenium distribution in the Tagus (Portugal) and Mersey (UK) estuaries	Metals	Mersey Estuary and Tagus Estuary	
University Thesis	PhD Thesis, University of Liverpool	1966	Sly PG	Marine geological studies in the eastern Irish Sea and adjacent estuaries, with special reference to sedimentation in Liverpool Bay and the River	Physical, Sediments, Hydrology	Mersey Estuary and Liverpool Bay	
Grey Literature	Mersey Basin Campaign, mid-term report	1997	Wood R	Mersey Basin Campaign: building a healthier economy through a cleaner environment	Socioeconomic, Management, Mersey Basin Campaign		
Grey Literature	North West Water, Warrington	1982	Harding JPC	Use of Enteromorpha as a monitor of heavy metal contamination in the Mersey Estuary- November 1979 to February 1982	Inorganic, Metals, Bioaccumulation, Macroalgae	Mersey Estuary	
Statutory Authority Document	Nature Conservancy Council	1983	Newton I	Birds of Prey and Pollution. (Part 3- Mersey estuary bird mortalities)	Birds, Pollution, Water Quality	Mersey Estuary	other parts of publication include; 1-monitoring, 2-pollutant residues in seabirds, 4-PCB residues in PCB dosed puffins, 5-incident investigations

Reference Type	Information Source	Date	Author/Contact	Title/Information Content	Keywords	Area of study	Comments/Summary
University Thesis	PhD Thesis, University of Salford	1980	Gargari AS	Preliminary investigations into the ecology of the intertidal diatoms of the Mersey estuary	Microalgae	Mersey Estuary	
University Thesis	PhD Thesis, University of Salford	1982	Srivastava KB	An ecological study of the fishes from the Mersey estuary with special reference to O-group Plaice (Pleuronectes platessa L.) and sand gobies (Pomatoschistus minutus p)	Fish	Mersey Estuary	
Academic Journal	PhD Thesis, University of Salford	1994	Allero BL	Utilisation of Environmental Impact Assessment (EIA) in assessment of impact of human interference on natural ecology of estuaries-a case study of Mersey estuary	Ecology, Socioeconomic	Mersey Estuary	
Statutory Authority Document	Cheshire County Council, document 479	1989	Cheshire County Council Environmental Planning Department	The Ecology of the Mersey Estuary	Ecology	Mersey Estuary	
Grey Literature	Plymouth Marine Laboratory	1996	Pope ND, Langston WJ, Burt GR	A survey of trace metals in biota of the Mersey estuary	Inorganic, Metals, Bioaccumulation	Mersey Estuary	
University Thesis	M.Eng Thesis, University of Liverpool	1967	Perry JG	Hydrodynamic Studies of the Tide Gauges.	Tidal Currents		
University Thesis	PhD Thesis, University of Liverpool	1971	Gardner D	Lipids of some invertebrates and studies of dissolved Mercury in sea-water	Invertebrates, Metals, Mercury, Water Quality		
University Thesis	PhD Thesis, University of Liverpool	1973.	Royle LG	The occurrence of trace metals in lakes, rivers and coastal waters.	Inorganic, Metals, Water Quality		
University Thesis	PhD Thesis, University of Liverpool	1976.	Murray AJ	Shortchain chlorinated aliphatic hydrocarbons in the natural environment.	Organic, Organochemicals		
University Thesis	PhD Thesis, University of Liverpool	1978.	Jones PD	Studies of the Marine Geochemistry of Mercury and other Heavy Metals.	Physical, Mercury, Metals		
Published Book	PhD Thesis, University of Liverpool	1981	Barber PC	A further investigation into the causes of beach erosion at King's parade on the north Wirral Coast.	Physical, Coastal Protection,	North Wirral Coast	
University Thesis	PhD Thesis, University of Liverpool	1990.	Abdul-Rashid MK	Studies of aliphatic amines and other volatile organic compounds in the marine environment.	Organic, Organochemicals		
University Thesis	PhD Thesis, University of Liverpool	1993.	Fitzsimons M	The geochemistry of methylamines in recent marine and lacustrine sediments.	Physical, Sediments		

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University Thesis	PhD Thesis, University of Liverpool	1996.	Ion NJ	The causes and effects of rising groundwater in Merseyside and Manchester.	Groundwater		
University Thesis	MSc Thesis, University of Salford	1976	Hodgson D	Mersey Birds: an assessment of the importance of the Mersey estuary for birds.	Birds	Mersey Estuary	
University Thesis	MSc Thesis, University of Salford	1976	Moreira MH	Estuarine inter-tidal macrofauna - an evaluation of two sampling methods.	Invertebrates		
University Thesis	MSc Thesis, University of Salford	1976	Chandrasekaran K	The zooplankton of the Mersey estuary.	Zooplankton	Mersey Estuary	
University Thesis	MSc Thesis, University of Salford	1976	Mak Wing Tak	The benthic fauna of a sandbank in the Mersey Narrows.	Invertebrates, Sediments	Narrows	
University Thesis	MSc Thesis, University of Salford	1976	Pollock ST	The ecology of fish in estuaries with particular reference to the River Mersey	Fish, Ecology	Mersey Estuary	
University Thesis	MSc Thesis, University of Southampton (Oceanography)	1985	Potter AW	Considerations of the errors involved in transport calculations in the Mersey estuary and predictions therefrom	Socioeconomic	Mersey Estuary	
University Thesis	MSc Thesis, University of Manchester (Pollution Research Unit)	1985.	Carter JJ	The influence of environmental contamination on the fauna of the Mersey estuary.	Ecology, Pollution	Mersey Estuary	
University Thesis	MSc Thesis, University of Manchester	1986	Rankin SC	The ecology of the Mersey estuary and the likely effects of the proposed Mersey barrage, with special reference to the bird populations of the area.	Ecology, Development, Birds	Mersey Estuary	
Grey Literature	Proudman Oceanographic Laboratory Report No.56.	1999	Woodworth PL	A study of changes in high water levels and tides at Liverpool during the last two hundred and thirty years with some historical background.	Sea level rise, Tidal Currents, History	Liverpool	
Grey Literature	North West Water. Rivers Division. Internal Report TS-BS-78-2.	1978	D'Arcy BJ, Wilson KW	Fish Surveys on the Manchester Ship Canal - The implications for Routine Chemical sampling.	Fish	Manchester Ship Canal	
Grey Literature	North West Water. Rivers Division. Internal Report TS-BS.78-4.	1979	D'Arcy BJ, Wilson KW	Fish in the tidal Manchester Ship Canal Feb 77-May 78.	Fish	Manchester Ship Canal	
Academic Journal	Estuarine and Brackish-water Science Association. Bull. No.20.	1980	D'Arcy BJ, Pugh-Thomas M	The occurrence and numbers of fish in screenings from a cooling-tower intake on the Manchester Ship Canal.	Fish	Manchester Ship Canal	

Reference Type	Information Source	Date	Author/Contact	Title/Information Content	Keywords	Area of study	Comments/Summary
Grey Literature	North West Water. Rivers Division. Internal Report TS-BS 80-3.	1980.	D'Arcy BJ	Indicators of Heavy Metal contamination in the Mersey Estuary.	Inorganic, Metals, Water Quality	Mersey Estuary	
Grey Literature	North West Water. Rivers Division. Internal Report TS-BS 80-4.	1980.	Williams, B.	Observations on the occurrence and distribution of invertebrates in part of the Mersey Estuary, November.	Invertebrates	Mersey Estuary	
Grey Literature	North West Water. Rivers Division. Internal Report TS-BS 80-5.	1980	Harding JPC	Concentration of Metals in Plant Samples from the Mersey Estuary.	Inorganic, Metals, Bioaccumulation, Plants	Mersey Estuary	
Grey Literature	North West Water. Rivers Division. Internal Report TS-BS 82-2.	1982	Chambers RG, Prigg RF, Harding JPC	Survey of Metals in Enteromorpha from the NWWA Coastline.	Inorganic, Metals, Bioaccumulation, Macroalgae		
Statutory Authority Document	Nature Conservancy Council	1986	Burd F	Saltmarsh survey of Great Britain. County Report, Merseyside and Cheshire.	Saltmarsh		
Academic Journal	Mar. Biol. Ass. UK.	1988	Langston WJ	A Survey of Trace Metals in Biota of the Mersey Estuary.	Inorganic, Metals, Bioaccumulation	Mersey Estuary	
Statutory Authority Document	Department of the Environment. WRc Report No. DoE 1754-M/2	1988	Cole AJ, Head PC	Metal flux Study.	Inorganic, Metals, Tidal Currents		
Grey Literature	North West Water WRc Report No. UC 828.	1990	Bealing, D.J., Wilson, V. and Sidorowicz, S.V.	The determination of nitrification rates in the tidal	Organic, Nutrients	Mersey Estuary	
Grey Literature	Mersey Oil Spill Project.	1990	Clark NA, Donald PF, Mawdesley TM, Waters RJ	The impact of the Mersey Oil Spill, August 1989 on the populations and distributions of waterfowl.	Oil, Birds	Mersey Estuary	A report by the British Trust for Ornithology to Mersey Oil Spill Project Advisory Group. Contract 3A
Grey Literature	Mersey Oil Spill Project	1991	EAU/Mersey Oil Spill Advisory Group	The Mersey Oil Spill Project 1989 90.	Oil	Mersey Estuary	A summary report of the studies undertaken into the long term environmental impacts of the August 1989 oil-spill into the Mersey Estuary.
Grey Literature	Mersey Barrage Company	1988	Mersey Barrage Company	Mersey bird distribution and feeding studies. November 1987-April 1988.	Birds	Mersey Estuary	Mersey Barrage Environmental Study.
Grey Literature	Mersey Barrage Company	1992	Environmental Resources Ltd	Intertidal Invertebrates in the Mersey Estuary: Statement of Methodologies July 1992.	Invertebrates	Mersey Estuary	Mersey Barrage Co. Stage IIIa Environmental Studies – E4
Grey Literature	Mersey Barrage Company	1992	Environmental Resources Ltd	Fish Studies in the Mersey Estuary. Statement of Methodologies. July 1992.	Fish		Mersey Barrage Co. Stage IIIa Environmental Studies – E3
Grey Literature	Mersey Barrage Company	1992	Environmental Resources Ltd	Plankton in the Mersey Estuary. Statement of Methodologies. July 1992.	Phytoplankton, Zooplankton	Mersey Estuary	Mersey Barrage Co. Stage IIIa Environmental Studies – E1
Grey Literature	Mersey Barrage Company	1992	Environmental Resources Ltd	Mersey Barrage Stage III: Volume 2. December 1991 Revised 1992.	Socioeconomic, Development	Mersey Estuary	Revised Draft Technical Report.

Reference Type	Information Source	Date	Author/Contact	Title/Information Content	Keywords	Area of study	Comments/Summary
Grey Literature	Marinetech North-West	1983	Turner MJ (ed)	Mersey Barrage Pre-Feasibility Study. Volume 2 Research Report.	Socioeconomic, Development	Mersey Estuary	
Grey Literature	Marinetech North West	1983	Turner MJ (ed)	Mersey Barrage Pre-Feasibility Study. Volume 3 Environmental Considerations.	Socioeconomic, Development	Mersey Estuary	
Grey Literature	Mersey Barrage Company	1988	Dept. of Energy-Contractor Report ETSU TID 4047	Tidal power from the River Mersey: a feasibility study Stage 1	Tidal Currents, Socioeconomic, Development	Mersey Estuary	
Grey Literature	The North of England Zoological Society	1989	Jones, B and Norgain, B	The Mersey Barrage- The proceedings of the Mersey Barrage Symposium	Socioeconomic, Development	Mersey Estuary	
Grey Literature	Mersey Barrage Company	1991	Dept. of Energy	Tidal power from the River Mersey: a feasibility study (Stage II report EWP(P))	Tidal Currents, Socioeconomic, Development	Mersey Estuary	
Grey Literature	Mersey Barrage Company	1991	Dept. of Energy-Contractor Report ETSU TID 4071	Tidal power from the River Mersey: a feasibility study Stage II report	Tidal Currents, Socioeconomic, Development	Mersey Estuary	
Grey Literature	Mersey Barrage Company	1991	TM Economics	Mersey Barrage feasibility study. Economic evaluation: waders and wildfowl. Contingent valuation method. EWP(P) 021.	Development, Socioeconomic, Management, Birds	Mersey Estuary	
Grey Literature	Mersey Barrage Company	1991	Environmental Resources Ltd	Mersey Barrage Environmental Study: Volume 3 Working Paper D. Invertebrate Studies in the Mersey. Draft EQP(P) 029	Development, Socioeconomic, Management, invertebrates	Mersey Estuary	
Grey Literature	Mersey Barrage Company Stage III Report. Final Report	1992	Mersey Barrage Company	Tidal power from the River Mersey. A feasibility study. .	Development, Socioeconomic, Tidal Currents	Mersey Estuary	
Grey Literature	Mersey Barrage Company	1991	Environmental Resources Ltd	Mersey Barrage Environmental Study. Stage 3. Draft Volume 3. Working Paper A. Plankton Studies. EWP(P) 026.	Development, Socioeconomic, Zooplankton, Phytoplankton	Mersey Estuary	
Grey Literature	Mersey Barrage Company	1991	Environmental Resources Ltd	Mersey Barrage Environmental Study. Stage 3 Draft. Volume 3. Fish and fisheries studies in the Mersey. EWP(P) 027.	Development, Socioeconomic, Fish	Mersey Estuary	
Grey Literature	Mersey Barrage Company	1991	Parkman Rendel	Mersey Barrage Studies - Stage 3. Flood Benefit Study.	Development, Socioeconomic, Tidal Currents, Coastal Protection	Mersey Estuary	
Grey Literature	Mersey Barrage Company	1988	Department of the Environment Contractor Report ETSU TID 4047	Tidal Power from the River Mersey: a Feasibility Study Stage 1.	Development, Socioeconomic, Tidal Currents	Mersey Estuary	

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Grey Literature	Mersey Barrage Company	1988	Mersey Barrage Company	Report presented to the members of the Mersey Barrage Ecology Consultative Forum. Chairman: Dr. F. J. Handley.	Development, Socioeconomic	Mersey Estuary	
Published Book	Mersey Strategy		The University of Liverpool Study Team	The Mersey Estuary Management Plan	Management Plan	Mersey Estuary	a comprehensive document which provides the vision and the framework for coordinated action
Grey Literature	University of Liverpool		University of Liverpool (Management Plan Study Team)	The Mersey Estuary Management Plan: Initial consultations with voluntary organisations and the private sector	Management Plan	Mersey Estuary	
Grey Literature	University of Liverpool	1993	University of Liverpool (Management Plan Study Team)	The Mersey Estuary Management Plan: Navigation, Tidal regime and level of use	Management Plan, Tidal Currents	Mersey Estuary	
Grey Literature	University of Liverpool		University of Liverpool (Management Plan Study Team)	The Mersey Estuary Management Plan: Informal recreation opportunities	Management Plan, Leisure	Mersey Estuary	
Grey Literature	University of Liverpool		University of Liverpool (Management Plan Study Team)	The Mersey Estuary Management Plan: Initial consultations with statutory agencies	Management Plan	Mersey Estuary	
Grey Literature	University of Liverpool		University of Liverpool (Management Plan Study Team)	The Mersey Estuary Management Plan: Land ownership and tenure	Management Plan	Mersey Estuary	
Grey Literature	University of Liverpool		University of Liverpool (Management Plan Study Team)	The Mersey Estuary Management Plan: The EC urban waste water treatment directive	Management Plan, Water Quality	Mersey Estuary	
Grey Literature	University of Liverpool		University of Liverpool (Management Plan Study Team)	The Mersey Estuary Management Plan: Water-based recreation	Management Plan, Leisure	Mersey Estuary	
Grey Literature	University of Liverpool (Management Plan Study Team)	1994	McGuinness A, Dennier A	The Mersey Estuary Management Plan: Tourism	Management Plan, Leisure	Mersey Estuary	
Grey Literature	University of Liverpool		University of Liverpool (Management Plan Study Team)	The Mersey Estuary Management Plan: Emergency Planning	Management Plan	Mersey Estuary	
Grey Literature	University of Liverpool	1994	University of Liverpool (Management Plan Study Team)	The Mersey Estuary Management Plan: Fishing in the Mersey Estuary	Management Plan, Fish	Mersey Estuary	
Grey Literature	University of Liverpool		University of Liverpool (Management Plan Study Team)	The Mersey Estuary Management Plan: Coast and Flood defence	Management Plan	Mersey Estuary	

Reference Type	Information Source	Date	Author/Contact	Title/Information Content	Keywords	Area of study	Comments/Summary
Grey Literature	University of Liverpool		University of Liverpool (Management Plan Study Team)	The Mersey Estuary Management Plan: The implementation of an estuary management plan: organisational structures and institutional arrangements	Management Plan	Mersey Estuary	
Grey Literature	University of Liverpool		University of Liverpool (Management Plan Study Team)	The Mersey Estuary Management Plan: Monitoring the management plan	Management Plan	Mersey Estuary	
Grey Literature	University of Liverpool		University of Liverpool (Management Plan Study Team)	The Mersey Estuary Management Plan:Estuary projects: an outline programme	Management Plan	Mersey Estuary	
Academic Journal	Estuaries 24 (2): 198-203	2001	Johnson MS, Copplestone D, Fox WM, Jones SR	Annual cycle of radionuclide contamination on tide-washed pasture in the Mersey Estuary, NW England	Inorganic, Radionuclides, Sediments	Mersey Estuary and North West England	radionuclide concentrations were dominated by the growth cycle of vegetation-higher contamination levels were found in winter than in summer.Flooding effects also observed.
Academic Journal	J.Chartered Institution of Water+ Env.management 14 (3): 193-199	2000	Belshaw C	The Mersey Valley sludge story: from sea to Shell Green	Sewage, Development	Mersey Valley	describes past shipping operations and the Mersey valley sludge pipeline, together with operating experiences, leading to the construction of the new sludge
Academic Journal	Environmental Toxicology 14 (4): 397-403	1999	McNeish AS, Bidleman T, Leah RT, Johnson MS	Enantiomers of methylhexachlorocyclohexane and hexachlorocyclohexane in fish, shellfish, and waters of the Mersey Estuary	Organic, Organochemicals, Fish, Shellfish, Bioaccumulation	Mersey Estuary	Mussels, dab, flounder and plaice were tested for hexachlorocyclohexane.
Academic Journal	Aquatic Conservation-Marine and Freshwater ecosyst. 8(5):685-700	1998	Nolan PA, Guthrie N	River rehabilitation in an urban environment: examples from the Mersey Basin, North West England	Development, Fish	Mersey Estuary and North West England	illustrates a multi-functional approach used in urban river rehabilitation-concludes that the involvement of teams within the local community is the key to success
Other	European Chemical News	1995	(Anon)	Unilever fined in River Mersey pollution case	Pollution	Mersey Estuary	
Academic Journal	Water, Air and Soil Pollution 75 (3-4): 265-275	1994	Jones SR, Rudge SA, Murdock RN	The dynamics of vegetation contamination by radionuclides on a tide washed pasture in the Mersey estuary	Saltmarsh, Sediments, Inorganic, Radionuclides	Mersey Estuary	found vegetation contamination was almost entirely due to sediment contamination, temporal variation was consistent with deposition of suspended sediments during tidal inundations
Academic Journal	J. Institution of Water+ Env.management 5 (3): 360-361	1991	Stoker TA	Proceedings of IWEM syposium on River Mersey- Change and Challenge, 1990	Socioeconomic	Mersey Estuary	

Reference Type	Information Source	Date	Author/Contact	Title/Information Content	Keywords	Area of study	Comments/Summary
Academic Journal	Water, Air and Soil Pollution 46 (1-4): 261-275	1989	Bobba AG, Lam DCL	Application of Hydrological model to acidified watersheds-A study on Mersey River and Moosepit Brook, Nova Scotia.	Hydrology, Physical	Mersey River	
Grey Literature	Civil Engineering-London	1985	(Anon)	Cleaning up the Mersey.	Development, Pollution, Socioeconomic	Hydrology	
Academic Journal	Water Services 88 (1066): 527-527 1984	1984	(Anon)	Helping to clean up the Mersey	Development, Pollution, Socioeconomic	Mersey Estuary	
Academic Journal	Engineer 257 (6662): 9-9	1983	Wyman V	Barrage plan for the Mersey	Development	Mersey Estuary	
Academic Journal	Water Pollution Control 82 (3):402-417	1983	West JR, Lin CH	An evaluation of a moving-co-ordinate system model of salinity intrusion into the Mersey estuary	Tidal Currents, Salinity	Mersey Estuary	
Academic Journal	Journal of Hygiene 89 (3):507-511	1982	Smith GR, Oliphant JC, White WR	Clostridium-Botulinium type-C in the Mersey estuary.	Bacteria	Mersey Estuary	
Published Book	from the Transactions of the Historical Society of Lancashire and Cheshire	1874	Boult J	The Deterioration of the Mersey	Pollution, Water Quality, History	Mersey Estuary	
Published Book	Literary and Philosophical Society, Warrington	1876	Vawser R	The Mersey.	History, Socioeconomic	Mersey Estuary	
Published Book	Longmans Green & Co (Vol 1) Liverpool Marine Biological Committee (Vol 2-5)	1886-1900	Herdman WA ed	Reports upon the fauna of Liverpool Bay and the neighbouring seas	Ecology	Liverpool Bay	
Published Book	Proc. and Trans. Liverpool Biological Society	1920	Herdman WA	Summary of the history and work of the Liverpool Marine Biological Committee.	History		
Published Book	Published book	1910	Coward, T.A	The Vertebrate Fauna of Cheshire and Liverpool Bay	Ecology	Liverpool Bay	
Published Book	Published book	1930	Mersey Docks & Harbour Board	Report of Committee appointed by the Mersey Docks and Harbour Board to investigate the effects of the discharge of crude sewage into the River Mersey	Sewage, Water Quality	Mersey Estuary	
Published Book	Hale, London	1950	Palmer WT	The River Mersey.	History	Mersey Estuary	
Published Book	Liverpool University Press for the British Association for the Advancement of Science	1953	Smith W (Ed)	A Scientific Study of Merseyside.	History, Ecology		

Reference Type	Information Source	Date	Author/Contact	Title/Information Content	Keywords	Area of study	Comments/Summary
Published Book	Royal Commission on Environmental Pollution. 1972.Cmnd 5054. HMSO	1971	Mersey & Weaver River Authority	Report on the Condition of the River Mersey and Adjacent Coastline.Third Report: Pollution in some British Estuaries and Coastal Waters	Pollution, Water Quality	Mersey Estuary	
Published Book	Liverpool University Press	1965	Mountfield S	Western Gateway. A History of the Mersey Docks and Harbour Board.	History	Mersey Docks	
Published Book	Royal Commission on Environmental Pollution. HMSO	1973	Porter E	Pollution in Four Industrialised Estuaries. Four case studies undertaken for the Royal Commission on Environmental Pollution. HMSO	Pollution, Water Quality		
Published Book	Steering Committee	1974	Watson JD, Watson DM	Merseyside. Sewerage and Sewage Disposal. Report for the Steering Committee on Pollution of the Mersey Estuary	Sewage, Pollution, Water Quality	Mersey Estuary	
Published Book	Macmillan Press Ltd., London	1977	McDowell DM, O'Connor BA	Hydraulic behaviour of estuaries	Hydrology, Tidal Currents		includes data on the Mersey
Published Book	Published book	1978	Jones PD, Head PC, Whitelaw K	A Data Recording Station to measure Water and Solids Fluxes through the Mersey Narrows.	Tidal Currents, Sediments	Narrows	In J. McManus (Ed) Proceedings of Symposium. "Marine and Estuarine Methodologies." Sept. 1987. Olsen & Olsen. Copenhagen
Published Book	In Proceedings of the 5th International Conference on Heavy Metals in the Environment.	1985	Whitelaw K, Cole JA, Head PC, Jones PD	Transport of Hg, Pb, Cr, Cu, Ni, Zn between the Mersey estuary and Liverpool Bay during selected tidal cycles	Tidal Currents, Inorganic, Metals	Mersey Estuary and Liverppol Bay	Cited in T. D. Lokkas (Ed). Proceedings of the 5th International Conference on Heavy Metals in the Environment, Athens, Sept 1985.Vol. 1. 377-379. CEP Consultants, Edinburgh
Published Book	Terence Dalton Ltd. Lavenham. Suffolk	1985	Freethy, R	The River Mersey.	Ecology, Socioeconomic	Mersey River	
Published Book	In "Estuarine Water Quality Management." W. Michaelis (Ed). Springer-Verlag. Berlin	1990	Head PC, Jones PD, Whitelaw K	Fluxes of Water, Solids and Metals through the Mersey Estuary (UK) as measured by a Continuous Data Recording Station (MIDAS).	Tidal Currents, Sediments, Metals	Mersey Estuary	
Published Book	In Proc. International Conf. on Environmental Pollution. Lisbon 1999. Vol. 2. Interscience Enterprises Ltd. Geneva	1991	Head PC, Jones PD	The Mersey Estuary: Turning the Tide of Pollution.	Polution	Mersey Estuary	
Statutory Authority Document	National Rivers Authority. Water Quality Series No. 24. HMSO	1995	National Rivers Authority	Contaminants entering the Sea: a report on contaminant loads entering the seas around England and Wales 1990-1993	Water Quality		Includes data on the Mersey
Statutory Authority Document	Environment Agency	1996	Environment Agency	The Environment of England and Wales: A Snapshot.	Ecology, Water Quality		Includes data on the Mersey

Reference Type	Information Source	Date	Author/Contact	Title/Information Content	Keywords	Area of study	Comments/Summary
Statutory Authority Document	Environment Agency	1998	Environment Agency	The State of the Environment in the North West of England.	Ecology, Water Quality		Includes data on the Mersey
Published Book	Marine Pollution Management Monitoring Group	1998	Marine Pollution Management Monitoring Group	National Monitoring Programme. Survey of the Quality of UK Coastal Waters	Water Quality		Includes data on the Mersey
Statutory Authority Document	Environment Agency	1999	Environment Agency	The State of the Environment of England and Wales: Coasts	Water Quality		Includes data on the Mersey
Book	Annual Reports for the Secretary of State	2001	Clift, J.F Acting Conservator of the River Mersey	Report on the State of the Navigation of the River Mersey (2000).	Shipping		
Grey Literature	Mersey Oil Spill Advisory Group	1991	Mersey Oil Spill Advisory Group	The Mersey Oil Spill Project 1989 - 1990.	Oil, Pollution,	Mersey Estuary	A summary report of the studies undertaken into the long term environmental impacts of the August 1989 oil-spill into the Mersey Estuary
Published Book	In "An inventory of UK estuaries. Volume 3. North-West Britain." compiled by A.L. Buck	1993	Joint Nature Conservation Committee	Mersey Estuary	Ecology	Mersey Estuary	
University Thesis	PhD thesis, University of Liverpool	1964	Sharaf El Din, S.H	The circulation and mixing processes in the river Mersey and Irish sea.	Tidal Currents, Physical	Mersey Estuary	
University Thesis	PhD thesis, University of Liverpool	1969	O'Dell M	Silt distributions and siltation processes with particular reference to the Mersey estuary and Dock system.	Tidal Currents, Sediments	Mersey Estuary	
University Thesis	PhD thesis, University of Liverpool	1969	O'Connor BA	Sediment movement in a tidal estuary.	Tidal Currents, Sediments	Mersey Estuary	
Academic Journal	British Association for the Advancement of Science Report for 1835, 64-65	1835	Denham, H.M	On the survey of the Mersey and Dee.	Ecology	Mersey Estuary and Dee Estuary	
Academic Journal	British Association for the Advancement of Science Report for 1837, 85-87	1837	Denham, H.M	On the tidal capacity of the Mersey Estuary.	Tidal Currents	Mersey Estuary	
Grey Literature	Mersey Barrage Company Stage III. Environmental Study. E1	1991	Mersey Barrage Company	Plankton studies in the Mersey Estuary.	Zooplankton, Phytoplankton	Mersey Estuary	Report prepared by Environmental Resources Ltd. on behalf of MBC, November, 1991
Grey Literature	Mersey Barrage Company Stage IIIa Environmental Studies. E2.	1992	Mersey Barrage Company	Salt Marsh Studies in the Mersey Estuary.	Saltmarsh	Mersey Estuary	Report prepared by Environmental Resources Ltd. on behalf of MBC, August, 1992
Grey Literature	Mersey Barrage Company Stage IIIa Environmental Studies E4	1992	Mersey Barrage Company	Intertidal Invertebrates in the Mersey Estuary.	Invertebrates	Mersey Estuary	
Grey Literature	Mersey Barrage Company Stage IIIa Environmental Studies. E3	1992	Mersey Barrage Company	Fish studies in the Mersey Estuary	Fish	Mersey Estuary	

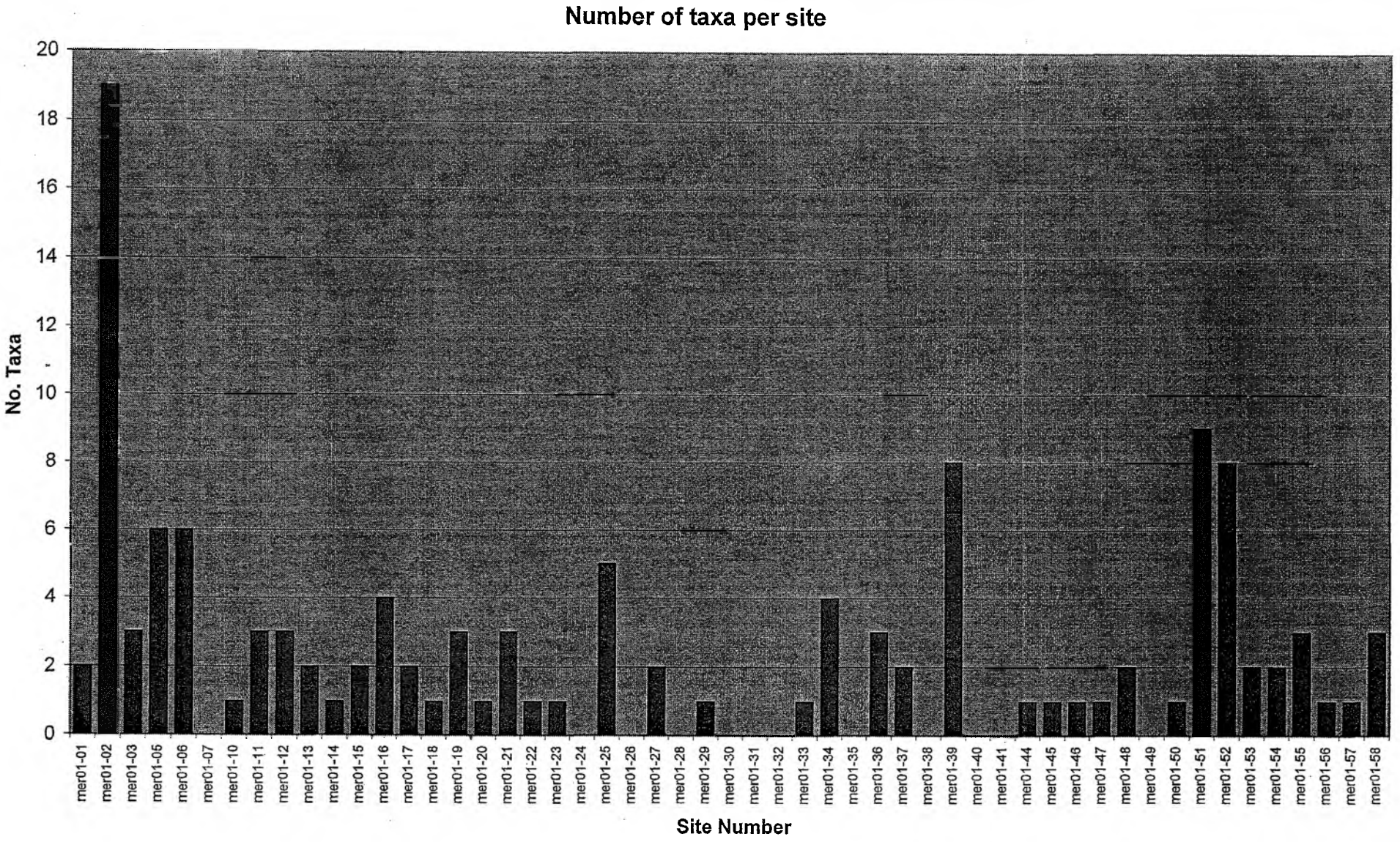
Reference Type	Information Source	Date	Author/Contact	Title/Information Content	Keywords	Area of study	Comments/Summary
Statutory Authority Document	Environment Agency, North West Region	1996	Dredging Research Ltd	Acoustic Measurements of Sediment flux through the Mersey Narrows, November 26th 1995 and January 10th 1996. Final Report.	Tidal Currents, Sediments	Narrows	Investigation commissioned by Environment Agency, North West Region
Grey Literature	Wallingford HR	1997	Wallingford HR	Estuary Morphology and Processes. A review of recent research and user needs.	Physical, Tidal Currents		Report SR 446. (Includes data on the Mersey)
Grey Literature	EMPHASYS Consortium MAFF Contract CSA 4938	1999	EMPHASYS Consortium	Estuary Research and Management	Management		Report of two-day workshop at HR Wallingford 4th and 5th October 1999
Grey Literature	EMPHASYS Consortium MAFF Contract CSA 4938	2000	EMPHASYS Consortium	Modelling Estuary Morphology and Process. Final Report. Estuaries Research Programme Phase 1.	Physical, Management		
Grey Literature	EMPHASYS Consortium MAFF Contract CSA 4938	2000	EMPHASYS Consortium	A Guide to Prediction of Morphological Change within Estuarine Systems. Version 1B.	Physical, Management		
Grey Literature	EMPHASYS Consortium MAFF Contract CSA 4938	2000	EMPHASYS Consortium	Recommendations for Phase 2 of the Estuaries Research Programme. Final Report.	Management		
Grey Literature	Liverpool Junior Chamber of Commerce	1963	Liverpool Junior Chamber of Commerce	Danger Pollution. Report on Pollution of the Mersey	Pollution	Mersey Estuary.	
Grey Literature	Lancashire and Western Sea Fisheries Joint Committee	1964	Croft JE	Preliminary report on the condition of the waters of the Mersey estuary 1960-1961	Water Quality	Mersey Estuary	Technical Report No.1 1960-1964
Grey Literature	Mersey and Weaver River Authority	1970	Mersey and Weaver River Authority	Introducing the Mersey and Weaver River Authority. What it is - what it does	Management		
Grey Literature	Mersey and Weaver River Authority	1971	Mersey and Weaver River Authority	Report on the Condition of the River Mersey Estuary and Adjacent Coastline. Warrington March 1971	Water Quality, Ecology, Management	Mersey Estuary	
Grey Literature	Lancashire and Western Sea Fisheries Joint Committee	1972	Lancashire and Western Sea Fisheries Joint Committee	Pollution and Fisheries in the Mersey Estuary.	Pollution, Fish	Mersey Estuary	Pamphlet (15 pp)
Grey Literature	Steering Committee WPR Report No. 447R	1974	Water Pollution Research Laboratory (Report No. 447R)	Effect of Polluting Discharges on the Mersey Estuary	Pollution	Mersey Estuary	Report of Investigations on behalf of the Steering Committee on Pollution of the Mersey Estuary-WPR Report No. 447R
Grey Literature	North West Water. Rivers Division. Internal Report TSS 77-10	1977	Jones PD	Oxygen Injection Trial (Monks Hall) 1977.	Water Quality, Oxygen		
Grey Literature	North West Water. Rivers Division. Internal Report TSS 79-2	1979	Jones PD	Mersey Estuary Tidal Cycle Surveys 1978.	Tidal Currents	Mersey Estuary	

Reference Type	Information Source	Date	Author/Contact	Title/Information Content	Keywords	Area of study	Comments/Summary
Grey Literature	North West Water. Directorate of Resource Planning. Internal Report.	1980	Anon	A cleaner Mersey - the way forward.	Pollution, Management	Mersey Estuary	
Academic. Journal	Chemistry and Industry. April 19th 1980. 321-327	1980	Buckley AD	The Mersey Estuary: a way ahead.	Management	Mersey Estuary	
Grey Literature	ENDS. July 1981. No.77. 10-12	1981	Anon	The North West Water Authority: Problems with the Mersey.	Management	Mersey Estuary	
Grey Literature	North West Water. Internal Report 26.8.82	1982	Nicholson M	Analysis of the Distribution of Marine Species in the Manchester Ship Canal.	Ecology, Invertebrates, Plants	Manchester Ship Canal	
Grey Literature	North West Water. Internal Report 26.8.82	1982	Nicholson M	Analysis of the Variation of Fish population structure from the Manchester Ship Canal.	Fish	Manchester Ship Canal	
Grey Literature	North West Water. Internal Report PL-SRD-83-1	1983	Head, P.C	Mathematical Modelling and Mersey Estuary Pollution Abatement.	Management, Pollution, Tidal Currents	Mersey Estuary	
Grey Literature	Greenpeace Research report RR3	1986	Greenpeace	The Greenpeace Great Rivers Campaign, Aquatic Environment Monitoring Research Report; The Mersey Estuary, a current status report.	Management, Water Quality	Mersey Estuary	
Grey Literature	ICES CM1988/C: 12	1988	Rowlatt S	Metal contamination in sediments from Liverpool Docks and the Mersey estuary.	Inorganic, Metals, Sediments	Mersey Estuary and Liverpool Docks	
Statutory Authority Document	Department of the Environment Contract PECD 7/7/144	1988	Cole AJ, Head PC	Mersey Metal Flux Study.	Tidal Currents, Inorganic, Metals	Mersey Estuary	Final Report to the DoE
Statutory Authority Document	National Rivers Authority NW region, Environmental Quality Dept.	1994	Edwards G	Heavy metal contaminants in fish caught from the Mersey estuary and inshore Liverpool bay	Inorganic, Metals, Bioaccumulation, Fish	Mersey Estuary and Inshore Liverpool Bay	
Statutory Authority Document	English Nature	2001	English Nature	Mersey Estuary. European Marine Site	Management, Ecology	Mersey Estuary	advice given under regulation 33 (2) of the Conservation (Natural Habitats) Regulations 1994, as amended. Contains Maps showing boundaries, sub-features and bird concentrations
Statutory Authority Document	UK Marine SACs Project	1999	ABP Reserch and Consultancy Ltd.	Natura 2000: Good practice guidelines for ports and harbours operating within or near UK European marine sites	Management, Development		
Grey Literature	CEFAS report	2000	Allen Y, Hurrell V, Jones C, Reed J, Matthiessen P	Endocrine disruptors and European marine sites in England	Organic, Organochemicals		
Grey Literature	Mersey Estuary Steering Group	1998	Anon.	Mersey Estuary Management Policies	Management	Mersey Estuary	

Reference Type	Information Source	Date	Author/Contact	Title/Information Content	Keywords	Area of study	Comments/Summary
Grey Literature	UK Marine SACs Project	1999	Anon.	Natura 2000: A review of the effects of fishing within UK European marine sites	Management, Fish		
Statutory Authority Document	Joint Nature Conservation Committee	1996	Barne JH, Robson CF, Kaznowska SS, Doody JP, Davidson NC	Coasts and Seas of the United Kingdom. Region 13: Northern Irish Sea, Colwyn Bay to Stranraer including the Isle of Man	Ecology, Management		
Statutory Authority Document	Department of the Environment, Transport and the Regions (DETR)	1999	Clift F	Report on the state of the navigation of the River Mersey to the Secretary of State for the Environment, Transport and the Regions	Shipping	Mersey Estuary	
Grey Literature	University of Glasgow	1993	Coastal Research Group	Estuaries Management Plans, Coastal Processes and Conservation- Mersey Estuary	Management Plan	Mersey Estuary	
Grey Literature	University of Glasgow	1993	Coastal Research Group	Estuaries Management Plans, Coastal Processes and Conservation- Mersey Estuary: Recommendations	Management Plan	Mersey Estuary	
Statutory Authority Document	UK Marine SACs Project	1999	Cole S, Codling ID, Parr W, Zabel T	Natura 2000:Guidelines for managing water quality impacts within UK European marine sites.	Management, Water Quality		
Statutory Authority Document	National Rivers Authority (NW region)	1996	Langston WJ, Burt GR, Pope N	Bioaccumulation of Methylmercury (Mersey Estuary)	Inorganic, Metals, Mercury, Bioaccumulation	Mersey Estuary	
Statutory Authority Document	Environment Agency	1998	Pope ND, Langston WJ, Burt GR, Chesman BS	Trace metals in biota from the Mersey Estuary- 1997	Inorganic, Metals, Bioaccumulation	Mersey Estuary	
Published Book	Mersey Basin Campaign, Liverpool University Press	1993	University of Liverpool study team	Mersey Estuary Management Plan. Area issue report: The Inner Estuary.	Management Plan	Mersey Estuary	
Grey Literature	Mersey Basin Campaign, Liverpool University Press	1995	University of Liverpool study team	Mersey Estuary Management Plan. A strategic policy framework	Management Plan	Mersey Estuary	
Statutory Authority Document	National Rivers Authority R&D note 346	1994	WRc plc	Nitrification rates in rivers and estuaries	Nutrients		
Statutory Authority Document	National Rivers Authority R&D note 203	1994	Plymouth Marine Laboratory	Effects of sediment metals on estuarine benthic organisms	Sediments, Metals, Invertebrates		
Statutory Authority Document	National Rivers Authority R&D note 328		Leah RT, Connor L, McNeish AS	Persistent Organic compounds within the Mersey Estuary: Environmental fate study	Organochemicals	Mersey Estuary	

ference Type	Information Source	Date	Author/Contact	Title/Information Content	Keywords	Area of study	Comments/Summary
ey Literature	Report by the Acting Conservator of the Mersey Estuary, HMSO	1993	Kendrick Mary	Navigation of the River Mersey	Shipping	Mersey Estuary	
atutory thority cument	Joint Nature Conservancy Council	1982	Fairhurst CP, Buxton NE	Saltmarsh Vegetation of the Mersey Estuary.	Saltmarsh	Mersey Estuary	A report for the Nature Conservancy Council
blished Book	Ecology and Landscape Development: A History of the Mersey Basin. Liv. Uni. Press	1999	Hawkins SJ, Allen JR, Fielding NJ, Wilkinson SB, Wallace ID	Liverpool Bay and the estuaries: human impact, recent recovery and restoration	Management	Liverpool Bay	Proceedings of a conference held at Merseyside Maritime Museum, Liverpool 5-6 July 1996. Edited by E.F Greenwood. Liverpool University Press.
atutory thority cument	Environment Agency	1998	Environment Agency	Lower Mersey Action Plan. October 1998	Management	Mersey Estuary	
atutory thority cument	Environment Agency	1996	Environment Agency	Alt Crossens Action Plan. October 1996	Management		
atutory thority cument	Environment Agency	1997	Environment Agency	Weaver/ Dane Consultation Report. October 1997	Management		
tutory thority cument	National Rivers Authority, NW region (Warrington)	1994	Pope ND, Langston WJ, Burt GR	A survey of trace metals in biota of the Mersey estuary-1993	Inorganic, Metals, Bioaccumulation		
y Literature	IERC, University of Liverpool	1994	Leah RT	Halogenated Pesticides, Solvents and Industrial Chemicals in Fish and Shell Fish from the Mersey Estuary and Liverpool Bay.	Inorganic, Organic, Organochemicals, Bioaccumulation, Fish, Shellfish	Mersey Estuary	Final Report of the Mersey Estuary and Liverpool Bay Environmental Research Consortium. IERC, University of Liverpool, 117pp
y Literature	Merseyside Ringing Group Annual Report 1989, pp.40-48	1990	Norman D, Coffey P	Waders at Bromborough Pool 1989	Birds		
utory hority cument	Cheshire County Council, Mersey Marshes Local Plan Technical Report 3	1978	Buxton NE	Stanlow and Ince Banks- The Wildlife Importance of the Banks	Ecology	Stanlow and Ince Banks	
y Literature	ICI, General Chemicals Division, Birmingham: Kynoch Press	1950	Hardy DW	A history of the chemical industry at Widnes	History, Development	Widnes	
lished Book	In Intertidal Sediment Biogeochemistry.	1994	McDonald P, Jones SR	The behaviour of radionuclides in the coastal and estuarine environments of the Irish Sea	Water Quality, Radionuclides		In Intertidal Sediment Biogeochemistry. Proceedings of Mineralogical Society and the Challenger Group. Cambridge: Cambridge University Press
demic nal	University of Liverpool	1995	Murdock RN	The use of Saltmarsh sediment cores to reconstruct historical pollution profiles in the Mersey and Ribble estuaries, UK	Saltmarsh, Sediments, History, Water Quality	Mersey Estuary and Ribble Estuary	

erence Type	Information Source	Date	Author/Contact	Title/Information Content	Keywords	Area of study	Comments/Summary
ademic urnal	Journal of Environmental Radioactivity 19:1-24	1993	Oldfield F, Richardson N and Appleby PG	AM-241 and CS-137 activity in fine grained saltmarsh sediments from parts of the NE Irish Sea shoreline.	Inorganic, Radionuclides, Saltmarsh, Sediments		
ademic urnal	Marine Pollution Bulletin 28 (4). 254-258, April 1994	1994	McNeish AS, Leah RT, Connor L, Johnson MS	Methyl-hexachlorocyclohexane in mussels (Mytilus edulis) from the Mersey estuary	Organic, Organochemicals, Bioaccumulation, Invertebrates, Shellfish	Mersey Estuary	Mussels from the Mersey found to contain notable concentrations of MCH and as yet unidentified homologues or isomers.
iblished Book	George M'Corquodale & Co.	1858	Hills GH	Essay of the hydrography of the Mersey Estuary	Tidal Currents	Mersey Estuary	
cademic urnal	Marine Environmental Research 51 (3). 213-227, April 2001	2001	Fox WM, Connor L, Copplestone D, Johnson MS, Leah RT.	The organochlorine contamination history of the Mersey estuary, UK, revealed by analysis of sedimnet cores from salt marshes.	Organic, Organochemicals, Sediments	Mersey Estuary	Sediment cores taken at Ince and Wides Warth describe historical trends in pollution from PCB, HCH and DDT. These show a progressive reduction over the last 30-50 years following enforcement of environmental legislation.
rey Literature	Mersey Basin Campaign, Liverpool University Press	1993	University of Liverpool study team	Mersey Estuary Management Plan. Report on water quality and nature conservation	Management Plan, Water Quality	Mersey Estuary	


Number of taxa per site
No. Taxa
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2
4
6
8
10
12
14
16
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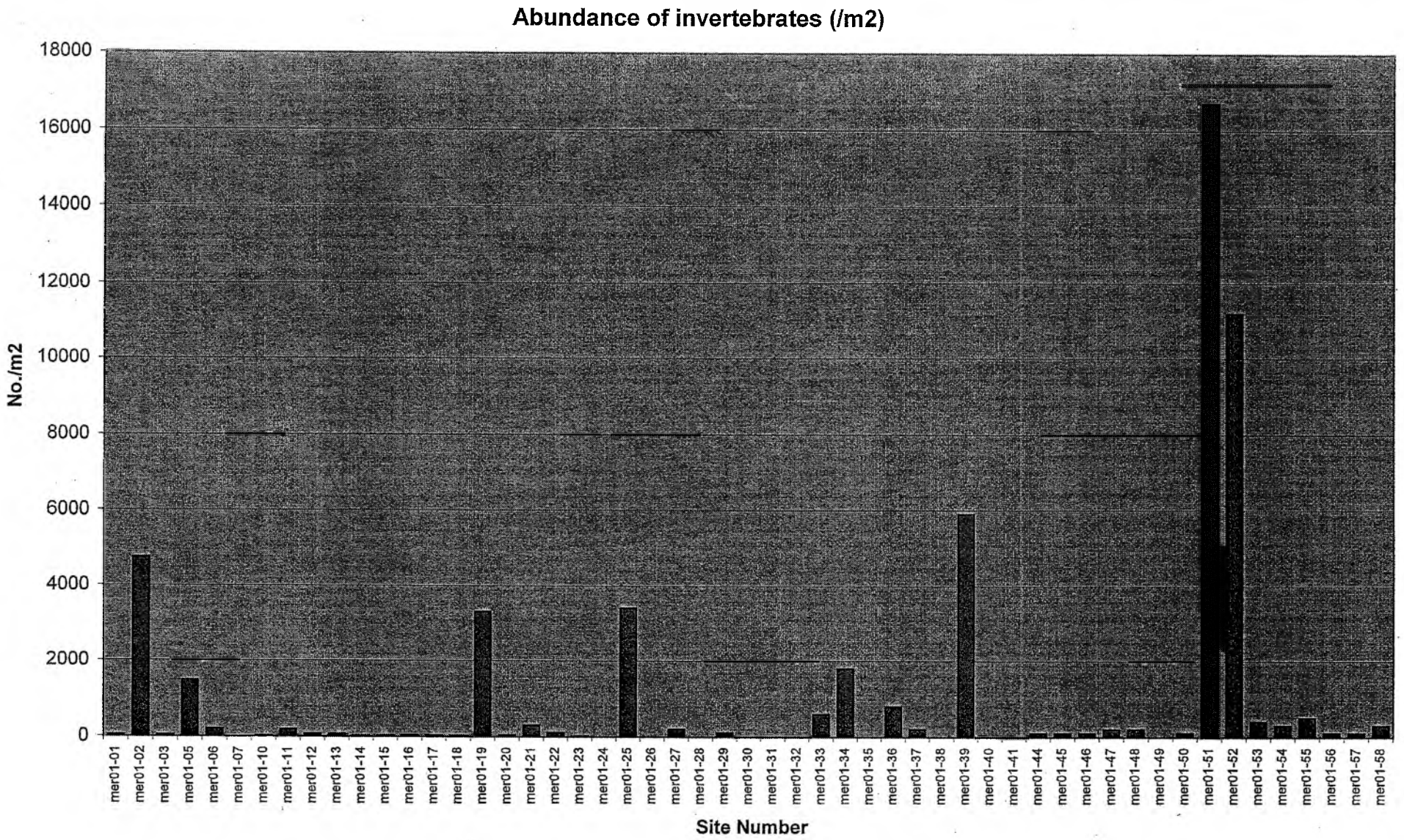
Site Number


Abundance of invertebrates (/m2)
No./m2
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
mer01-01
mer01-02
mer01-03
mer01-05
mer01-06
mer01-07
mer01-10
mer01-11
mer01-12
mer01-13
mer01-14
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Site Number